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Director's Biennial Report—1924-1926

October, 1926

Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

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TO THE PRESIDENT OF THE COLLEGE

Sir:

I have the honor to submit herewith the report of the Agricultural Experiment Station of Oregon State Agricultural College for the biennium ended June 30, 1926. The report includes a brief account of the work and results during the two years, and again directs attention to certain urgent needs of the Station.

J. T. JARDINE,
Director.

October, 1926.

Director's Biennial Report

OREGON AGRICULTURAL EXPERIMENT STATION

1924-1926

October, 1926

THE purpose of this report is to continue the record of Station work presented in the past three reports. The work of the Oregon Agricultural Experiment Station for the two years ending June 30, 1926, is discussed briefly and important needs of the Station in the way of land and improvements are pointed out.

In form and scope the report intentionally follows closely the form and scope of preceding reports. The idea is to make the record continuous for reference in experiment station libraries and among workers of experiment stations and other similar agencies. For use by farmers and the general public the results of the investigations and their application to agricultural enterprises are printed in station bulletins, station circulars, station circulars of information, technical journals, and press articles by the hundreds, and are presented through lectures, radio, correspondence, and conferences. The Director's Biennial Report is not designed or intended for such use.

Progress with the Station work during the two years has been perhaps more satisfactory than in the past. A greater volume of investigations has been possible due to increased State and Federal funds, and with these funds it has been practicable to round out certain investigations along important lines which heretofore have not been as thorough as desired. The two years, on the other hand, have brought many new problems making it as difficult as ever for the Experiment Station staff to meet the requests for investigations. Meritorious requests for investigations in equal or larger numbers than two years ago are awaiting study by the Station. As stated in the last report of the Director, the time will perhaps not come when even the larger number of investigations needed and worthwhile can be undertaken as soon as the need is apparent.

The need of strengthening the Station work along certain lines especially is pointed out later. At the same time no definite request for increase in funds is made. It is believed that additional appropriations should be primarily at the request and as a result of efforts by the people engaged in the agricultural enterprises to be benefited.

The demand for Station publications still is far in excess of editions which it is possible to finance. It is still necessary to limit distribution to individual copies upon request except to the mailing lists including experiment stations and an approved list of libraries. By liberality in keeping libraries supplied with file copies and with the cooperation of individuals interested it is hoped that every copy of a bulletin or circular will be put to the best use and that no really important need will be un-

filled. Requests for numbers of copies to be used as texts in connection with teaching can not be met. As far as practicable in such cases two copies are furnished, one for the instructor, and one for library reference.

Attention is again called to the demand upon the Station staff in rendering service through letters, conferences, laboratory examinations, field days, radio, and field trips requested through the Extension Service.

COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE

VALUABLE cooperation in several important investigations has been continued by the United States Department of Agriculture and new cooperation has been undertaken.

Forage crop investigations were continued in cooperation with the Office of Forage Crop Investigations, Bureau of Plant Industry. Of this same Bureau the Office of Cotton, Truck and Forage Crop Disease Investigations increased cooperation and assigned a man to Corvallis for potato disease investigations; the Office of Pine Blister Rust Control continued the campaign to control White Pine Blister Rust; the Seed Laboratory continued its office at Corvallis; the Branch Station at Moro was continued in cooperation with the Office of Cereal Investigations; the Branch Station at Hermiston in cooperation with the Office of Western Irrigation Agriculture Investigations; and cooperative studies of pear harvesting and storage and of prune storage were undertaken.

The soil survey in cooperation with the Bureau of Soils was continued and representatives of this Bureau assisted in economic surveys of irrigation projects.

The Bureau of Agricultural Economics gave valuable assistance in a study having to do with the marketing of Oregon butter and with the cooperation of this Bureau a study of the raw milk situation at Portland, Oregon, was started near the close of the biennium.

The Division of Agricultural Engineering, Bureau of Public Roads, has cooperated in studies on methods of irrigation and assisted in making economic surveys of irrigation projects.

This formal cooperation of the Federal Bureaus and much informal cooperation and assistance have aided greatly in the progress of the Agricultural Experiment Station work.

OREGON COMMITTEE ON RELATION OF ELECTRICITY TO AGRICULTURE

IN MAY, 1924, the Oregon State Committee on the Relation of Electricity to Agriculture was formed to cooperate with the National Committee and other state committees on this subject.

The Oregon Committee on the Relation of Electricity to Agriculture is composed of a group of farmers, representatives of farmers' organizations, public utility representatives, equipment manufacturers and distributors, and others interested in the possibilities of the use of electricity

on the farm. It is one of the seventeen similar committees organized in as many different states within the past three years.

The purpose of the Oregon Committee is to determine in what ways electricity can be profitably adapted to power and other requirements of the farm. The Committee's activity is directed to obtaining facts regarding possible farm uses and making these facts available to the public.

The Agricultural Experiment Station of the College was designated to carry on the investigations.

The Committee has financed investigations to the extent of approximately $6,000 annually. During 1924-25 part time of two technical men was devoted to the investigations. During 1925-26 one full time Agricultural Engineer has been in charge of the projects and he has been given cooperation by members of the regular Station staff on problems of their respective departments.

Excellent cooperation has been given by farmers, the public utility representatives, equipment manufacturers and distributors, and others.

Results of the investigations in brief form have been published in annual reports of the Oregon Committee.

The studies have progressed far enough to indicate much possibility along this line but there is need for reliable specific information. It is hoped the work of the Committee can be continued and perhaps be expanded.

THE FEDERAL PURNELL ACT

THE Federal Purnell Act was passed by Congress and was approved by the President February 24, 1925. In accordance with Section 2 of the Act proper certification was made by the Governor of Oregon to the Secretary of the Treasury authorizing Oregon State Agricultural College to receive the funds.

This Act was "To authorize the more complete endowment of agricultural experiment stations, and for other purposes." The first money from the fund, $20,000, became available for the fiscal year beginning July 1, 1925. These funds have made possible undertaking studies relative to cost of production, harvesting and storage, standardization and marketing requested and much needed by farmers of the state and to undertake studies in the field of Home Economics. These last were begun December 1, 1925.

SOME OUTSTANDING STATION ACCOMPLISHMENTS OF THE BIENNIUM

IN the Director's Reports for 1920-1922 and 1922-1924 a few illustrations were given of investigations which had reached a point to indicate results of outstanding benefits. Some of these items justify further mention. Other results of real promise have developed during the two years to illustrate the possibilities of assistance to agriculture through the Agricultural Experiment Stations. Of greatest importance, naturally, is the generally satisfactory progress of work on several hundred major

and minor problems. Without satisfactory work on the entire program the chances would be greatly reduced for periodically being able to report a few accomplishments of such economic value as to more than justify the entire Station expenditures. The illustrations given, therefore, are intended more to indicate the possibilities from work of the Agricultural Experiment Stations than as a measure of the results during the past two years.

FEDERATION WHEATS

The introduction and development of Federation wheats was mentioned as of importance in the report for 1920-1922. Marked benefits to farmers during the succeeding two years were cited in the report for 1922-1924, showing that one community in 1924 had benefited to the extent of $60,000 due to increased yield from these wheats compared with yields of wheat previously grown.

The value of the Federation wheats, Federation and Hard Federation, was more strikingly emphasized in 1925. During the winter of 1924-25 a large part of the winter wheat of the Columbia Basin was winter-killed. Upon recommendation of the Moro Station and the county agricultural agents about 400,000 acres of Federation wheats were seeded to replace the winter-killed fall-sown wheat. The average yield of these two varieties was at least 3 bushels per acre more than any other spring wheats seeded. This meant about 2½ million dollars to the farmers of Eastern Oregon. Federation and Hard Federation, first distributed from the Moro Station in 1921, are now the important commercial spring wheats in Eastern Oregon.

Two selections from Hard Federation made at the Moro Station are apparently superior to Hard Federation in yield and in some plant characters. A limited quantity of these will be distributed to farmers for trial in the spring of 1927.

SMUT-RESISTANT WHEATS

In the past two reports mention has been made of progress toward commercial wheat varieties immune to both species of stinking smut. In the fall of 1926 the Branch Station at Moro will distribute 250 bushels of a new smut-resistant winter wheat which has been named Regal. In field plot trials at Moro, Regal has slightly outyielded the standard Turkey wheats. This variety is a purple strawed selection from Turkey 1571. It is sufficiently resistant to smut that seed treatment will be unnecessary.

Two other promising smut-resistant winter wheats are being tested out. One of these, Turkey 889-5, may be a higher yielding wheat than Regal in some localities. White Odessa has been the highest yielder of the smut-resistant, white kerneled varieties. The average plot yields of Regal for four years, 1923 to 1926, inclusive, were 28.6 bushels per acre; the average for White Odessa 27.8 bushels per acre; the average for Kharkov, the standard wheat of the Turkey type in Eastern Oregon, 27.5 bushels per acre.

There is every indication that these new smut-resistant wheats will compare favorably in other qualities and will be equal or will exceed the standard Turkey wheats in yield. This promises to be an accomplishment which wheat farmers have been awaiting for years.

MARKTON, A SMUT-RESISTANT OAT

Markton oats, a smut-immune variety developed at the Moro Station, is now an established commercial variety in the Northwest. It is proving well suited to much of the territory, is a high yielder, and immune to smut. Hybrids with Markton and other commercial varieties have resulted in a number of promising smut-immune types with plump, white kernels. These are being increased and tested for yield.

LEGUMES FOR WESTERN OREGON

Hungarian vetch continues as a promising vetch for Western Oregon on heavy soils not so well suited to other vetches. Hairy vetch is finding favor in the Eastern market and its culture is increasing. Purple vetch continues to be grown in a number of places as a seed crop to be marketed largely in California. Woolly Podded vetch offers promise as a forage plant in some sections of the Coast District. Monantha vetch is attracting attention, and plans are under way for its multiplication as rapidly as the market may justify. A new early vetch, No. 13430, has promise because of earliness and greater resistance to aphis probably than ordinary Common vetch. It is being multiplied for distribution. The Austrian winter field peas, introduced in the fall of 1923, have made a remarkable showing. If they continue to look so desirable they will be of considerable consequence as a seed crop.

These several vetches are listed among the accomplishments because the growing of legumes in Western Oregon has been a problem for many years. Legumes were grown, but the problem has been to develop markets in addition to consumption as feed and forage in order to aid in establishing not only more profitable agriculture, but enough legumes to assist in maintenance of proper soil conditions.

AN OUTSTANDING POULTRY RECORD

For several years the Experiment Station has been continuing a poultry breeding project with the main object of developing a strain of birds which will be profitable layers for a longer period of years than present flocks. A pen of 200 Barred Plymouth Rock pullets from this new breeding stock has completed the first year's laying at the date of this report, October 4, 1926. The average production for the 200 birds was 233.9 eggs. Five of the pullets have already exceeded 300 eggs and four more should be well over the 300 mark before the laying year of each individual hen is completed.

One hen of this flock laid 335 eggs. This is but 4 eggs under the world's record for Barred Plymouth Rocks and is a new national record.

To increase the profitable laying age of the hen, vitality is an important factor. The mortality in this 200 flock has been closely watched. The loss during the laying year will be approximately 7 percent. Recent figures from laying contests in the Mississippi Valley indicate a mortality of 13 percent and this ordinarily is considered favorable.

THE CONTROL OF INFECTIOUS ABORTION IN DAIRY CATTLE

As a result of years of experimental work the Station veterinarians make the announcement for 1926 that it is not more difficult technically to eradicate abortion than to eradicate tuberculosis. This conclusion is based upon laboratory and controlled experiments followed by cooperative tests with dairy farmers in the control of the disease in several counties of the state. The importance of this finding is apparent when it is realized that the average decrease in production following infection with this disease is from 20 to 25 percent, which represents a tremendous economic loss.

SALMON POISONING IN DOGS

For years the Agricultural Experiment Station has at times been called upon for diagnosis and treatment of valuable dogs poisoned from eating salmon. Until the past 18 months the real cause of the disease had been undetermined. As a result of research of more than two years the Veterinary Medicine department has established beyond doubt that the trouble is due to a microscopic intestinal fluke.

The parasite has been isolated and has been identified by Doctor Chapin, of the United States Department of Agriculture, Bureau of Animal Industry, Zoological Division, as *Nanophyetus salmincola,* hitherto undescribed.

The symptoms, pathology, and a satisfactory method of diagnosis have been worked out.

Aside from considerable economic value to follow from this discovery the accomplishment is considered worthy of special mention as an achievement in research.

ADDITIONAL AGRICULTURAL ENTERPRISES NEED EXPERIMENT STATION ASSISTANCE

THE past two reports have called attention to agricultural enterprises in need of assistance from the Agricultural Experiment Station which could not be rendered. Year after year the situation changes slightly, but as a whole new needs develop as rapidly as those mentioned in previous reports are taken care of. At the time of this report there are a number of agricultural enterprises which have possibility and need technical assistance.

FIBER FLAX INDUSTRY

In the last report attention was called to the need of assistance for the development of the fiber flax industry in the state. Late in 1925 investigations were started in cooperation with the Office of Fiber Flax Investigations of the Department of Agriculture and with flax growers of Marion county to collect more information on the soil conditions suitable for flax, on varieties and strains, methods and time of seeding, harvesting, irrigation, and other cultural problems. The first season's results were not entirely satisfactory due to lack of adequate control of the field tests and difficulty of conducting investigations at a distance from headquarters.

A cost-of-production and enterprise survey covering about 50 farms was made during the summer of 1925. The results were later tabulated. This gave some valuable information on factors affecting success in the industry. The study should be continued to be of real service.

There is real need for thorough, well organized, continuous investigations over a period of several years.

THE BULB INDUSTRY

The growing of bulbs in Oregon continues to increase rapidly. In cooperation with the Federal Department of Agriculture the observations on control of diseases and pests have been strengthened slightly. The investigations on diseases and insect pests and their control, however, are entirely inadequate to the needs of this rapidly growing, highly specialized industry. The bulb growers have cooperated, and they have been given every assistance practicable with the funds and facilities available to the Station. The fact should be recognized that there will probably be many unsolved difficulties unless more comprehensive studies are undertaken.

HOPS

The hop industry in Oregon has possibilities beyond present development. It usually brings in from a million to 3½ million dollars a year. Additional investigations were undertaken during the biennium in irrigation and to some extent in control of pests. There is still need and opportunity for varietal testing, improvement, and cultural methods for this crop. Oregon's yield per acre is less than that for other important states. There is need also for additional work on control of pests and with fertilizers.

BEE INDUSTRY

There still is need for investigations in connection with the bee industry. Requests have continued over a number of years for such assistance. Studies to determine the best management systems for different sections of the state and surveys to determine cost of producing honey and the most important cost items are needed. Winter care and protection against diseases are problems which can be properly handled only by accumulating additional experimental data.

GROWING ROSES FOR PERFUME

The Agricultural Experiment Station is periodically criticised for not conducting the necessary tests to demonstrate possibilities of commercial growing of roses in Oregon for the manufacture of perfume. Before a reliable conclusion is reached on this point experiments will be necessary to determine the amount of oil and cost of production of oil from leading varieties suitable for production of commercial oils. This study would involve considerable expense and, for this reason, has not been undertaken. Negotiations have been under way with the Federal Government for cooperative studies and it is hoped that these will materialize during the next year.

MINT CULTURE

For a number of years the Agricultural Experiment Station has been doing a small amount of work relative to the production of mint in Oregon. In cooperation with the Federal Department of Agriculture varietal tests were made in search of more promising varieties. Limited tests were made on varieties and cultural practices.

This industry, however, is far outgrowing the scope of work of the Station. Requests for information have greatly increased during the biennium. The best interests of the industry would be promoted by more comprehensive and thorough investigations. These probably will not be undertaken during the next biennium.

PRESENT STATION INVESTIGATIONS NEED STRENGTHENING ALONG MANY LINES

ATTENTION has been called in preceding reports to individual investigations and lines of investigations under way by the Oregon Agricultural Experiment Station which are in need of strengthening. In the report for 1922-1924 progress was indicated toward strengthening investigations of diseases of small fruits. These important problems have been further taken care of by undertaking investigations of the strawberry weevil. There are still problems both of disease and of insect control which can not be undertaken.

COST OF PRODUCTION AND FARM MANAGEMENT STUDIES

Cost of production and farm management studies have been listed in previous reports as important for further attention. With the passage of the Federal Purnell Act sufficient funds were assigned to the Farm Management department, beginning July 1, 1925, to make possible thorough investigations in this field. Cost-of-production and enterprise studies are being given first attention. It is planned to continue well organized work in this field indefinitely.

MARKETING INVESTIGATIONS

Marketing investigations also have been mentioned as of importance for organized investigations. The Purnell funds have made possible undertaking several studies in this field. Attention has been given first to problems closely related to the handling of the individual commodity. In cooperation with the Bureau of Agricultural Economics, for example, a study of problems involved in the marketing of butter from Oregon creameries was made in 1925. It is planned further to strengthen investigations in this field during the next year.

VEGETABLE GARDENING

Perhaps there is no field more in need of comprehensive Station investigations than the field of vegetable gardening. The Station investigations should be materially strengthened along this line at the earliest possible opportunity. Little can be accomplished by assignment of a small amount of funds. Land, equipment, and a full time Station staff member are essential to the thorough work needed. These probably can not be provided during the next two years.

FARM CROPS PROBLEMS

Past reports have directed attention to the need for more thorough investigations in the production and marketing of farm crops. Even in the field of production there is much yet to be accomplished despite frequent statements to the effect that the production end of agriculture is far in advance of marketing. From the Moro Branch Experiment Station a high yielding, smut-resistant commercial wheat is being released in 1926. In plot yields this new wheat has not only proved smut-resistant, but is a high yielder. This accomplishment may increase the margin of the Eastern Oregon farmers. The Moro Station has released a smut-immune oat. Similar work is much needed for Western Oregon. It is being undertaken on a small scale, but not in the comprehensive way necessary to get results in reasonable time. Western Oregon has been a fertile field for investigations with legumes. The forage crop investigation in cooperation with the Federal Department is one of the most thorough investigations at the Oregon Agricultural Experiment Station considering that the field includes so many crops, such as vetches, all the clovers, alfalfa, beans, peas, and others. The investigation might profitably be considerably expanded.

The big problems of weed control, pasture development and maintenance, and crop standardization have barely been touched. For real progress in any of these fields land, equipment, and approximately one man's time are important. This means approximately $5,000 annually for each unit. Little has been done or will be done in the next few years in these new lines.

SOIL INVESTIGATIONS

The Oregon Agricultural Experiment Station program in the fields of soil fertility, soil management, drainage and irrigation is still weak compared with the importance of the problems.

There has been little expansion in this field during the past two years. Soil fertility investigations should be expanded to include more field trials with fertilizers, and laboratory and greenhouse studies should be materially strengthened.

Drainage is still an important problem in Western Oregon, and in the irrigated sections. Experimental work has been undertaken but more is needed, especially in connection with reclamation and irrigation of lands which might be subject to injury from excess of alkali. There are probably three million acres of Oregon lands which will eventually need drainage and they are so situated as to be valuable future lands.

There is still much to be learned in the use of irrigation water. The amount of water, rather than the land, is the limiting factor in reclamation in some areas and the use of more water than is necessary in all cases is expensive, and in some cases dangerous, because of injury to the crops and permanent injury to the land.

A volume might be written on this subject, but the brief statements here given will be ample support for the statement that the Station program should be strengthened in this field along the lines indicated.

CROP PEST AND HORTICULTURAL PROBLEMS

The need of more thorough investigations on breeding, cultural, and fertilizer problems of small fruits has been mentioned in each of the past two reports.

During late 1925 and early 1926 land was obtained and plantings made for tests of brambles and strawberries under irrigation on river-bottom land. A survey of strawberry production on fifty farms was undertaken also. The aim of this survey is to get reliable information on production costs, yields, and difficulties on different soils and with different varieties, and to find out the real possibilities of the industry. A thorough study of strawberry weevil and its control was started in 1926 in the Willamette Valley and at Hood River, and observations were begun on minor diseases and pests.

The small fruits industry, however, is growing more rapidly and has promise in greater measure than the scope of investigations under way. There is still much need for varietal testing to improve quality of stock, for cultural work to improve methods of handling the yards, and for fertilizer tests to work out the most economical production. These are important items for an intensive industry such as the small fruits industry, located usually on land near roads, schools, and towns, and therefore of high valuation.

Problems of orchard fertility in Oregon, especially in the Willamette Valley, have hardly been touched. The seriousness of the situation is emphasized by an appeal from the Salem Chamber of Commerce for assistance in finding out why certain prune orchards have not produced as they should for several years. No definite conclusions can be reached from a study of this nature in less than three and perhaps more than three years. This delay is an economic loss. Such facts should be available in advance. On the whole question of orchard fertility in the Wil-

lamette Valley the difficulties are always ahead of us, instead of the Station being able to anticipate the problem and save unwarranted losses.

While our systematic studies along this line are no better than they were when the last report was presented, the evidence is more marked as to possibilities. The problem is complex, involving many types of soil and many fruit crops. The investigation is such that it should extend over a number of years and be given at least the attention of one full time staff member with cooperation from several departments. The very magnitude of the undertaking has been such that it must be deferred until there are more funds, land, and facilities, or until other projects are taken care of.

Within the past two years there have been definite resolutions by organizations and communities asking the Station to undertake investigations looking to the control of the Syneta fruit beetle, a comparatively new and serious insect attacking cherries. There have been like resolutions and requests for investigation of the strawberry crown-borer. Damage by this insect has been unusually severe the past biennium in old plantings and in one-year-old plantings.

Cannerymen much desire that measures be worked out for suppression of the gooseberry fruit worm. This pest is becoming a limiting factor in gooseberry production. Sometimes as high as 30 to 50 percent of the berries are infected.

Walnut growers still desire further investigations to determine the varieties and seedlings of walnuts which will give the best results in Oregon. This information available now would prevent many plantings which will have to be worked over or pulled out later.

It has not been possible for the Station to meet a request made by the horticultural group at the State Agricultural Economic Conference in January, 1924. This group requested that the Station continue the collection and compilation of statistics and other data helpful to the growers in determining planting policies for the various fruits.

The whole field of spraying practice has been much complicated by the introduction of dusting instead of spraying with liquids for the control of diseases and insects. The change has brought many new problems and many questions. Comparative merits of the two methods can be determined only through careful study and experimental tests. To do this with the complicated spray program of the state will require years. Thus far little has been done. It is possible that the problems of spraying and elimination of spray from the fruit before marketing will become one of the main investigations even at the expense of other important studies now under way.

The past two years have brought more reports and requests for information regarding diseases of crops such as squash, onions, horseradish, tomatoes, celery, and melons. Losses in the squash crop of 1926 are heavy. Likewise, in some localities there will be heavy loss in some of the other crops. This is a field about which little is known.

Clover mildew, stem rot of clover and alfalfa, filbert blight, walnut blight, apple aphids, and other difficulties are the object of repeated in-

quiries which can not be answered with certainty. Facts are lacking and will become available only through investigations by the Oregon Agricultural Experiment Station or some other investigating agency.

DISEASES OF SHEEP

The need of investigations to determine causes of losses among range sheep and range cattle was mentioned in the Director's last report. The Oregon Wool Growers Association urgently requested that investigations of losses among sheep be made on the sheep ranges during 1926. It was planned that some work along this line would be undertaken, but it has not been possible.

Internal parasites are a main limiting factor to development of the sheep industry in the Willamette Valley. Calls are increasing for assistance in this field. Control measures can best be developed through investigations.

DISEASES OF POULTRY

Diseases of poultry have become one of the limiting factors in expansion of Oregon's commercial poultry industry. The poultrymen of the state obtained an appropriation of $5,000 annually for disease investigations, beginning in 1925. With these funds thorough investigation into a few of the more important diseases was undertaken. Results apparently are pleasing to the poultrymen.

At the time of this report, however, it has been necessary within one week to advise poultrymen in some important poultry producing centers that the Station staff can be of no assistance because nothing is known of troubles resulting in startling losses among their flocks. The poultrymen originally planned a larger appropriation to cover the additional disease investigations. A reduction in the appropriation made it impossible to carry out their entire program.

Every effort is being made to concentrate on investigations rather than to devote the time to work of practicing veterinarians. There are now, however, requests for 40,000 tests for white diarrhea among poultry and large numbers of inquiries by letter and personal visits. If the poultrymen continue patient for a few years so that uninterrupted investigations can be continued the Station should be able to give help. The nature of the troubles is such that this help will not be forthcoming if the investigators are forced to spend their time in examination of flocks in the field.

The work placed under way during the past two years is thorough and effective. There are still important troubles, however, which can be undertaken only by enlarging the funds and staff.

POULTRY INVESTIGATIONS

Poultry investigations now are concentrated mainly upon breeding and diseases. Some work was undertaken the past year for accumulation of further information on brooding and on the economics of lighting the laying houses.

The State Poultrymen's Association in recent meetings passed a resolution asking that the Station undertake additional investigations on incubation, with special reference to humidity and temperature. There is need for further investigations on brooding and feeding. No expansion in the poultry program will probably be feasible within several years.

SERVICE AND REGULATORY

THE Station staff, as in past years, was called upon to render assistance in many ways aside from that reported under investigations. This service, through correspondence, field examinations, conferences with growers and groups of growers, laboratory tests and Station field days, lectures, and radio, no doubt ranks high in service to Oregon agriculture. Such service at times is a costly interruption to experimental work under way. On the other hand, the staff members are thus kept in close contact with the practical problems of the farmers and are better qualified to plan and carry out investigations with a clear objective.

As illustrations of the extent of service rendered, the department of Veterinary Medicine again made more than 6,000 agglutination tests for abortion, aside from those in connection with experimental work; approximately 2,000 laboratory diagnoses; 1,400 office conferences with livestock owners; and 150 visits to farms at the request of the farmers. Several thousand inquiries were replied to by letter.

The department of Bacteriology made approximately 700 tests of water for individual farms and communities. More than 750 tests of milk were made annually. Other tests of foods were also made. Many of these tests involved several letters following the analyses of samples in order to assist in correcting existing troubles.

All departments of the Central Station at Corvallis and the seven branch stations are called upon for a similar amount of service in their respective fields.

The heavy correspondence, field assistance through the Extension Service, radio programs, and other services along similar lines are possible only through devotion and long hours of work on the part of staff members. Should demands along this line increase further it will be necessary to make further adjustments in order to protect the investigational work.

STATION FIELD DAYS

Field days were continued at each of the stations. At the Central Station, Corvallis, a week of field days was held in 1926. Farmers from counties of the Willamette Valley came in groups under the leadership of their respective county agents. The entire Station staff was available on these days to conduct the visitors over the Station work and direct attention to experiments and findings of particular value to farmers of the respective counties.

Similar field days were held annually at each branch station. In this way, many farmers have appreciated, as never before, the possibili-

ties of the Agricultural Experiment Stations as a means of solving their problems and bringing to them the best crops and practices for their respective districts without expensive trials by the farmers individually. The field days are growing in popularity and effectiveness.

EXHIBITS

During each of the two years the Agricultural Experiment Station prepared an elaborate exhibit for the Oregon State Fair. A smaller exhibit was made each year at the Pacific International Livestock Show. The State Fair exhibit has involved all departments and most of the branch stations. It has required considerable expenditure of time on the part of staff members and funds for travel and materials. The results have been rather carefully observed, and it is believed they have been worth while.

REGULATORY

The Agricultural Experiment Station staff administer the Fertilizer Inspection Law, the Lime Law, the Insecticide and Fungicide Law, the Dairy Bull Registration Law, and the Stallion Registration Law. Brief statements regarding this work are included under the respective departments.

GREENHOUSES, LAND, AND STORAGE NEEDED

GREENHOUSES

THE urgent need of greenhouse space was emphasized in the two reports of the Director covering the four years up to June 30, 1924. No additional space has yet been provided. The Station is still limited to one small section of greenhouse. It was expected that new houses, comprising part of an adequate system to be constructed over a period of a few years, would be available before the end of the biennium. Due to lack of funds the buildings were again deferred.

The most simple needs of the Station workers with soils, crops, and plant diseases can not be met. The point has been reached where lack of greenhouse space is a limiting factor in important lines of work.

LAND

The field work in farm crops and soils irrigation and drainage is scattered about on several rented farms. The College farm has little land available suitable for plot experiments. The drainage field, which has been in operation for a number of years and growing more valuable each year, will probably be taken over for campus development within a year.

Obviously, successful Station work in these lines requires land in adequate quantity and of character suitable to represent the problems to be solved. Compared with the branch stations the Home Station is limited in this respect and there is a corresponding limitation in the development of outstanding results.

A tract of 50 acres was rented for a period of ten years in late 1925. This was for the purpose of conducting irrigation experiments on field crops and small fruits on river-bottom land suitable for this purpose, and for which water can be obtained by pumping with a reasonable lift. The ten-year lease is the longest we have yet been able to obtain. Even this is not long enough. The results will be growing in value and the work will just be well established at the termination of the rental period.

Several hundred acres of land suitable for the experimental work of the Crops department and of the Soils department must be obtained if we are to develop the Station work as it should be developed to meet the problems of Western Oregon.

The need of a satisfactory orchard site also has been discussed in the last two reports of the Director. There is no hope of bringing into bearing a commercial orchard, or of doing satisfactory experimental work on the orchard site now available. Already the Station is handicapped by having to cooperate with growers in much of its orchard experimental work. The situation grows more serious each year.

The stations at Hood River and Talent are essentially for study of fruit problems. These two stations are reasonably well equipped with land. The land needed at the Home Station is to meet orchard conditions in the Willamette Valley and for studies fundamental to orcharding in all territories.

The Branch Station at Hermiston is making little progress at the present time, owing to lack of land. Plans have been under way for several years for a new station site which will be adequate to meet the needs for experimental work in that section. The land in view can not be obtained and placed under operation, however, until water becomes available under the Greater Umatilla Project. There is no definite assurance as to when this will come about.

In December, 1925, Hood River county obtained an orchard tract of approximately 35 acres and turned it over to Oregon State Agricultural College for the use of the Hood River Branch Experiment Station. This area is excellent in location, soil type, and plantings. It will not meet the ultimate needs of the Station, but gives an opportunity for the development of experimental work needed in the immediate future.

SEED HOUSE AND STORAGE HOUSE

Storage facilities for the care of valuable seed stocks and for experimental work are still lacking. Space is needed for service by all departments.

The lack of cold storage facilities at the Home Station has made it necessary to conduct storage investigations with fruits at Medford and at Hood River, where adequate, properly equipped storage rooms have been provided by the fruit industry. This arrangement is excellent for investigations at these two points, but should be supplemented by similar facilities at the Home Station. These are necessary to check results and to make possible a greater quantity of work with less expense by minimizing travel.

REPAIRS AND REPLACEMENTS

The College provided excellent laboratory facilities for the new investigations in poultry diseases in 1925. Enlargements and repairs were made at the Burns Station to accommodate an additional technical man. At the Burns Station, also, a Kohler lighting plant was installed and general repairs taken care of.

Such repairs as were necessary to keep the buildings in reasonably good order were made at each of the other branch stations.

Following the fire in Science Hall the Station laboratories for the department of Agricultural Chemistry were repaired and changes made which very materially improve the working conditions and provide more space, which was much needed.

Additional changes to provide office space were made for the Farm Crops department, and were planned and approved to take care of the increased staff in Farm Management.

EQUIPMENT

Expenditures for equipment were limited to purchases absolutely necessary for continuing the work, except in connection with new units established with Purnell funds. A number of the departments are in need of equipment to replace some of the present equipment and to meet the expanding needs. This is particularly true of the departments of Soils and Farm Crops.

The lysimeter tanks and weather equipment of the Soils department west of Cauthorn Hall may have to be moved because of campus expansion. Before this is done similar facilities should be provided elsewhere. This department is in need of additional laboratory equipment. The Farm Crops department is in need of additional laboratory equipment.

During 1926 plans were formulated for installing at branch stations and at the Home Station selected electrical equipment for experimental and practical tests of such equipment as a means of reducing labor and increasing profits on the farm. This plan will be followed out in the hope of making the branch stations serve the purpose of their respective agricultural communities with information regarding such equipment, both for field use and in the home.

During the biennium it was necessary to increase the number of Ford cars to furnish transportation for Station workers. The demand upon the Station staff and the number of problems which should be undertaken under conditions different from those at Corvallis make it imperative that transportation be available without losing time waiting for trains and busses, and for cooperators to transport the men from the transportation lines to the various fields where work is under way. This transportation problem is going to continue increasing in importance. Just how far the Station should go in the purchase of Ford cars to meet this need is a question. For lines of field work continuing well through the year a car should undoubtedly be provided.

The time is approaching when the Station will find it necessary to expend a considerably larger amount of funds for equipment.

PUBLICATIONS

EIGHTEEN Station Bulletins and twenty Station Circulars were prepared and issued during the two years. The average edition of bulletins was approximately 5,000 copies, and of circulars 4,000 copies.

With these small editions it is not possible to maintain individual mailing lists, and it is not possible to meet the demands for publications from out of state. The policy outlined in the Director's Report for the biennium ending June 30, 1924, was continued during the biennium. The library and institutional mailing list has been much increased in order to place publications available with these agencies. A list of available bulletins and circulars is sent periodically to individual persons, and individual copies furnished while they are available. Requests for copies in numbers to be used in connection with teaching have not been filled. Usually two copies are furnished, one for the instructor and one for his departmental library to supplement the general library copies for use by students.

With proper cooperation in carrying out this policy every copy of Station publications should reach some one who is particularly interested in the subjects reported. This will keep editions to a minimum size and make possible more prompt publication of the results of investigations.

In addition to the bulletins, circulars, and technical papers in journals, circulars of information were started during the biennium. These bear a number and the Station headings just as the bulletins and circulars do. They are mimeographed. The purpose is to make available information not in other form for distribution. This plan aids in answering inquiries. It reduces letter writing and aids in promptness of reply when specialists on the given subjects are absent.

As in past years, there are occasional complaints because new publications are exhausted within a few months. Libraries, however, have copies on file and the Station still continues to hold a small reserve for emergency needs.

The Station will continue this policy, issue small editions, make each publication as concise as practicable, and try to keep the published information as nearly up to date as seems warranted without danger of premature, faulty suggestions and conclusions.

The following publications were issued during the biennium:

BULLETINS

Number	Title	Edition	Pages
206	Studies Relating to the Harvesting and Storage of Apples and Pears	5,000	32
207	The European Earwig	3,000	32
208	Filberts	6,000	40
209	Dry-Farm Crop Rotation Experiments at Moro, Oregon	4,000	48
210	A Progress Report of Alkali Land Reclamation Investigations in Eastern Oregon	4,000	28

Number	Title	Edition	Pages
211	A Study of the Biological Activities in Certain Acid Soils	4,000	28
212	Pollination and Growing of the Cherry	5,000	40
213	Common Vetch	10,000	32
214	Blight Resistance in Pears and Characteristics of Pear Species and Stocks	6,000	100
215	Phloridzin	5,000	24
216	The Control of Core Break-down in Pears	8,000	16
217	Perennial Canker of Apple Trees	4,000	20
218	Fattening Lambs for the Late Winter Market	6,000	12
219	Cost of Producing Mutton and Wool on Eastern Oregon Ranges	6,000	16
220	Cost of Producing Beef on the Ranges of Eastern Oregon	6,000	24
221	Potato Wilt and Its Control	5,000	24
222	European Canker of Pomaceous Fruit Trees	3,000	56
223	The Tree Crickets of Oregon	4,000	20

CIRCULARS

Number	Title	Edition	Pages
57	Supplemental Irrigation for the Willamette Valley	3,000	8
58	Commercial Fertilizers	1,000	20
59	Apple Blister-mite and Its Control	4,000	8
60	Flax in Oregon	2,500	12
61	Preliminary Studies Relating to the Harvesting and Canning of Sweet Cherries	3,000	24
62	Costs and Profits of Sheep on Irrigated Farms	4,000	16
63	Extraction and Clarification of Pectinous Fruit Juices	5,000	12
64	The Chemical Composition of Insecticides and Fungicides	3,000	16
65	Insect Pests of Truck and Garden Crops	6,000	40
66	Building Plans and Bill of Materials for O. A. C. Portable Brooder House	7,000	8
67	Field Production of Ettersburg 121 Strawberry	3,000	16
68	Sprays, Their Mixing and Compatibility of Various Combinations	8,000	12
69	O. A. C. Portable Poultry Fence	5,000	4
70	Cutworm Control in Oregon	5,000	8
71	Reprint of Circular 35, Cherry Fruit Fly	3,000	4
72	Reprint of Circular 39, Tree Borers and Their Control	4,000	8
73	Cankers of Apple and Pear in Oregon and Their Control	5,000	32
74	A Survey of Marketing Problems Confronting Oregon Creameries	5,000	20
75	Studies Relating to the Harvesting of Italian Prunes for Canning and Fresh Fruit Shipment	4,000	24
76	Apple Thinning in Hood River Valley	4,000	12

SUMMARIES OF PUBLICATIONS

BRIEF summaries of the bulletins and circulars published by the Station during the biennium are presented below, together with reference lists of articles by members of the Station staff published during the biennium in the Journal of Agricultural Research and other periodicals.

206. **Studies Relating to the Harvesting and Storage of Apples and Pears,** Henry Hartman.

This bulletin deals with investigations in harvesting and storage of pears and apples grown in the Willamette Valley during the year 1923. It shows the adaptability of the pressure tester in showing the maturity of pears and also the impracticability of its use as a means of determining maturity in apples. Relation of humidity to loss of weight in Bartlett pears, time of picking in relation to loss of weight, effect of type of wrappers upon loss of weight, factors affecting the pressure test, relation of time of picking to quality and time of ripening, core rot of pears, are the principal subjects treated in the portion of the bulletin devoted to pears.

Time of picking in relation to size and to keeping quality and effect of removal of "bloom" on the keeping quality are the chief subjects treated in the part devoted to apples.

207. **The European Earwig,** B. B. Fulton.

This bulletin reports the results of several years' study of the European earwig. It discusses the distribution, means of spreading, habits, food and type of injury, control measures and life-history. The European earwig has been present in Oregon since 1909, but did not attract much attention until several years later. It is a pest chiefly on account of its disagreeable habit of concealing itself in or about houses. It is also destructive to garden vegetables and flowers. The best method of control is by means of a poison bait scattered about in the evening. Sodium fluoride is recommended as the best poison from the standpoint of both effectiveness and economy.

208. **Filberts—Part I. Growing Filberts in Oregon. Part II. Experimental Data on Filbert Pollination,** C. E. Schuster.

The adaptability of filberts to different conditions of soil, climate, altitude in Oregon and the Pacific Northwest is discussed. A description of thirty-two varieties is given, together with the botanical classification of varieties of Corylus. The principal factors in the growing and harvesting of filberts, such as propagation, planting, pruning, cultivation, bearing age, harvesting and drying are discussed.

209. **Dry-Farm Crop Rotation Experiments at Moro, Oregon,** D. E. Stephens.

This bulletin gives results from thirty-three crop rotations which have been carried on at Moro, most of them since 1912. The data presented in this bulletin, while emphasizing the superior crop yields obtained from the small grains on dry lands, show that at least one

leguminous crop, field peas, and one cultivated crop, corn, can be grown successfully in rotations with grain on much of the wheat-growing area of Eastern Oregon. Of the many rotations tried with grains and other crops, from the standpoint of profit, the following were the most successful: (1) spring wheat—peas; (2) spring wheat—corn—barley; (3) winter wheat—fallow; (4) winter wheat—peas—winter wheat—fallow; (5) winter wheat—peas—peas; (6) spring barley—fallow.

210. **A Progress Report of Alkali Land Reclamation Investigations in Eastern Oregon,** W. W. Johnston and W. L. Powers.

Four years' field and tank experiments with hard alkali land in Malheur Valley are reported. A method of sluicing deep drainage ditches was reported as result of experiments in this connection, which made it possible for farmers under favorable conditions to obtain cheap drainage. Leaching alone has been effective in removing the neutral salts, but has not been effective in removing the sodium carbonate or improving the physical condition. Leaching and drainage in connection with chemical treatment have been found necessary in order to remove the neutral salt resulting from the decomposition of sodium carbonate. Seven tons of gypsum per acre have been required to neutralize the sodium carbonate sufficiently to obtain a good stand of sweet clover. The application of 500 pounds of sulfur with 20 tons of manure per acre makes it possible to obtain a fair yield of rye and a good stand of sweet clover. There is indication that a heavier application of sulfur alone would be effective. The effects of combinations of sulfur with quicklime, with gypsum, and with manure are under investigation. Five tons of alum have been required to soften the soil; lighter applications have been ineffective. Manure has been effective when in combination with sulfur, but not when used alone. Getting uncleared, drained "grease wood" land into pasture and using frequent irrigation has proved to be an economical method of utilizing the hard alkali land in Malheur county and affords partial reclamation. Tank experiments have verified field results and show the value of heavy gypsum, sulfur, and alum treatments.

211. **A Study of the Biological Activities in Certain Acid Soils,** W. V. Halversen.

A study of the relation of lime to the production of plant food in some typical Willamette Valley soils. Laboratory, greenhouse, and field experiments show that lime stimulates the nitrifying power of these soils and a corresponding increase in the nitrate content of fallow field plots was observed. Under greenhouse conditions an increase in the yield of clover was obtained where moderate quantities of lime were applied. The relation of liming to the hydrogen-ion concentration in these soils is reported. These investigations indicate that lime has a stimulating effect upon those forces that operate in the production of plant food in the soils studied.

212. **Pollination and Growing of the Cherry,** C. E. Schuster.

After outlining the work done by the Oregon Agricultural Experiment Station begun by Gardner in 1913 and showing the absence of uniform results in the orchards top-worked to cross-pollenizing varieties, the bulletin gives an outline of work pursued, methods of crossing, selec-

tion of pollenizers, certification of trees known to be good pollenizers, and the satisfactory results obtained in orchards when this system of selection was followed.

The second part of the bulletin takes up practical phases of growing the cherry, such as districts suited to production, varieties, locating an orchard, propagation, planting, pruning, cultivation, and harvesting.

213. **Common Vetch,** H. A. Schoth and G. R. Hyslop.

Vetch is the most important annual legume grown in Oregon with an annual production of 15,000 to 45,000 acres. The many uses of vetch are presented. Suitability to different soils, rate of seeding, time of seeding, seeding in mixtures, harvesting rotations, and fertilizers are considered.

214. **Blight Resistance in Pears and Characteristics of Pear Species and Stocks,** F. C. Reimer.

This bulletin gives the results obtained during the first ten years of our search for blight-resistant varieties of pears and pear stocks. It reports the results obtained with practically all the known species of pears and varieties when inoculated with pear blight. A thorough discussion is presented of the merits and limitations of the various types suitable as stocks for our cultivated varieties of pears. In this study it was found that the five most valuable species of pears are the French type, *P. communis*, the Manchurian species, *P. ussuriensis*, the central Chinese species, *P. calleryana*, the birch leaved pear, *P. betulaefolia*, and the Japanese type, *P. serotina*.

215. **Phloridzin—Part I. The Significance of Phloridzin in Apple and Pear Tissue. Part II. The Hydrolysis and Estimation of Phloridzin,** E. M. Harvey.

The first part of this bulletin deals with the relation of phloridzin to the growth of shoots of the apple and pear and also the distribution of phloridzin within the shoots. The second part treats of the experimental procedure used in the hydrolysis of phloridzin.

216. **The Control of Core Break-down in Pears,** Henry Hartman.

This bulletin covers such subjects as the nature of core break-down, variety susceptibility, and the economic importance of the trouble. The experimental data deal with time of picking in relation to core break-down and the relation which the kind and manner of storage bear to the control of the break-down.

217. **Perennial Canker of Apple Trees (A preliminary report),** S. M. Zeller and Leroy Childs.

In this bulletin is described the perennial canker of apple trees, a disease which in its earlier stages is very difficult to distinguish from the apple-tree anthracnose caused by *Neofabraea malicorticis*. The disease differs from apple-tree anthracnose at least in four distinct ways: (1) its perennial character, (2) it is more distinctly a wound parasite than anthracnose, (3) the shape of the canidia and (4) its reactions on media in culture. Since the causal fungus appeared to be undescribed the name *Gloeosporium*

perennans Zeller and Childs has been proposed and "perennial canker" has been used as a common or horticultural name for the disease. The fungus also produces a fruit rot of the apple very similar in appearance to that produced by *Neofabraea malicorticis,* the cause of apple anthracnose.

No preventive measures of control are yet positively known for this canker disease. The liberal use of bordeaux mixture, particularly the spring application of bordeaux-oil, however, appears to be of some assistance in checking the advance of the disease. Seemingly, woolly aphids are associated with the infections and advance of the canker. Exposed woolly aphids can be controlled by the application of Black Leaf 40, 1 part to 1,000 parts of water, plus calcium caseinate spreader, 2 parts to 100 parts of water, given as soon as the insects begin to appear. Eradication involves cutting out the diseased tissues and painting the wounds with an antiseptic wound dressing.

218. **Fattening Lambs for the Late Winter Market,** H. K. Dean and E. L. Potter.

The object of the tests described in this bulletin was to study methods of fattening lambs for the March and April market, partly to take advantage of the better prices which normally prevail during the late winter months, and partly to market a larger quantity of alfalfa. The more important points of the bulletin may be summarized as follows: (1) From October until April the average increase in the Portland lamb market is 52 cents per hundred pounds per month. (2) Lambs to be marketed in March and April should be fed alfalfa alone until 60 to 90 days prior to the time they are to be marketed and then given grain at the rate of one pound per head per day. (3) Small lambs on hay alone will eat about 80 pounds of hay per month. (4) Feeding lambs hay alone for a while before beginning the grain feeding makes it possible to market twice as much alfalfa on a given investment in lambs and grain.

219. **Cost of Producing Mutton and Wool on Eastern Oregon Ranges,** E. L. Potter and H. A. Lindgren.

This bulletin aims first, to present a fair picture of the financial status of the sheep business in Eastern Oregon; second, to show simple methods of estimating costs of production which will enable the producers to figure out their own costs more accurately; and third, to point out the financial importance of certain management practices and thus lead the way toward cheaper production and greater returns.

220. **Cost of Producing Beef on the Ranges of Eastern Oregon,** E. L. Potter.

The more important cost items set forth in this bulletin are as follows: (1) The farm costs per 100 pounds of cattle are as follows: Grass steers, $9.75, winter fed steers $11.50, beef cows $8.00, weanling calves $9.27, and yearlings $8.70. (2) The cost of running a breeding cow one year is $27.10. (3) The cost of running a mixed herd one year is $21.40 per head.

221. **Potato Wilt and Its Control,** M. B. McKay.

This bulletin gives a summary of the results of eight years' work with potato wilt. It gives the measures that are effective in controlling the disease.

222. **European Canker of Pomaceous Fruit Trees,** S. M. Zeller.

This bulletin on European canker of pomaceous fruit trees describes the canker in its various manifestations on apple and pear, the latter of which is more seriously affected under the climatic conditions of Western Oregon. A technical description of the causal organism (*Nectria galligena* Bres.) and its physiological reactions are given in addition to the occurrence and prevalence of the disease in relation to climatic and soil factors and the various propensities of the trees which make them susceptible to infection. Control measures are both preventive and eradicatory. Results of inoculations and spray tests indicate that one application of bordeaux mixture 4-4-50 as late as practicable will give satisfactory control of new infections. Eradication measures consist of orchard sanitation and elimination of diseased tissues from cankers or the complete removal of cankered branches.

223. **The Tree Crickets of Oregon,** B. B. Fulton.

This bulletin discusses the injury, life-history, and control measures of the tree crickets in Oregon. Three species of tree crickets are found in Oregon: the Snowy Tree Cricket, the Prairie Tree Cricket, and the Western Tree Cricket. Prune, apple, peach, loganberry, raspberry, blackberry, and grape are subject to tree cricket injury. Control is accomplished by means of a spray of lead arsenate in late June or early July. On berries they may be controlled by a scattering application of a sweetened poison bait.

Soil Report of Clackamas County, A. E. Kocker, et al.

This report is just off the press and contains a soil map showing each soil type in color, description of each soil type and recommendations as to their improvement and management.

Soils Report of Polk County, E. F. Torgerson, et al.

This report is in press. It deals with Polk county soils as described for Clackamas county. Similar reports have been prepared and will be published soon describing the field work completed for Lane and Linn counties and the Grande Ronde Valley.

STATION CIRCULARS

57. **Supplemental Irrigation for the Willamette Valley,** W. L. Powers.

A brief statement presenting results of investigations for the period 1907 to 1924 indicating the value of supplemental irrigation wisely used for most late season crops on the naturally drained free working soils of the Willamette Valley. The soils and crops best suited to such irrigation and the advantage for each are pointed out. Cost of a small pumping plant; operation of such a plant; fourteen years' results from use of such a plant, and other topics are discussed.

58. **Commercial Fertilizers,** R. H. Robinson.

This circular discusses the fertilizing ingredients of commercial fertilizers, distinguishes between their agricultural value and commercial

value, and records "guaranteed" and "found" percentages of plant food elements in all brands offered for sale in Oregon in 1924.

59. **Apple Blister-mite and Its Control,** Leroy Childs.

The distribution and identity of species, habits and character of infestation, character of injury, migration and control measures are treated briefly. The circular is based upon experimental work following a sudden and wide-spread appearance of the blister-mite in the Pacific Northwest.

60. **Flax in Oregon,** G. R. Hyslop.

A brief popular discussion covering flax growing in Oregon with suggestions as to suitable soils, rotations, seed-bed preparation, weed control, seed and varieties, seed treatment, rate and date of seeding, harvesting, threshing, and retting.

61. **Preliminary Studies Relating to the Harvesting and Canning of Sweet Cherries,** Henry Hartman.

This circular deals with the factors relating to the time of picking of sweet cherries such as firmness, sugar content, acid content, weight, dessert quality, shipping quality, and color. It discusses methods of testing cherries for determining maturity and contrasts the pressure test with specific gravity test. Loss of weight after harvest, causes of decay in sweet cherries and time of picking in relation to canning quality are discussed.

62. **Costs and Profits of Sheep on Irrigated Farms,** E. L. Potter and Robert Withycombe.

In this circular the financial side of sheep raising is considered under three heads: maintenance costs, interest and depreciation of investment, and income. Winter feed is one of the heaviest items of maintenance costs. A flock of 100 head will require 25 tons of hay for winter feeding and 20 acres of irrigated pasture. The labor for the entire year is about 350 hours. It costs $11.66 to produce a yearling ewe and the cull value of the worn-out ewe is $4.00. The average annual death loss is 6 percent. Fourteen percent of the ewes should be culled each year.

With lambs at $0.10 and wool at $0.40, a farm ewe should pay $8 a ton for hay, $3 a year for pasture, $0.40 an hour for labor, 8 percent on investment, and an additional clear profit of $0.72.

63. **Extraction and Clarification of Pectinous Fruit Juices,** James C. Bell and Ernest H. Wiegand.

This circular deals briefly with the pectin in fruit juices, preparation of fruits for the extraction of pectin and the extraction, clarification and methods of concentration of pectinous juices.

64. **The Chemical Composition of Insecticides and Fungicides,** R. H. Robinson and W. W. Yates.

In this circular are given the essentials of the recently enacted Oregon Economic Poison Act, a list of registered manufactures for the calendar year 1925, and a brief discussion of the first year inspection work.

65. **Insect Pests of Truck and Garden Crops,** Don C. Mote.

This circular discusses briefly the more important vegetable insects in Oregon covering their life-history, type of injury, and method of control.

66. **Building Plans and Bill of Materials for O. A. C. Portable Brooder House,** Alfred G. Lunn.

67. **Field Production of Ettersburg 121 Strawberry,** C. E. Schuster.

This circular contains the observations on a survey of the Ettersburg 121 strawberry which covered 372 acres of plantings. Subjects of fertilizers, pollination, soil drainage, altitude, cultivation, irrigation and soil types are covered.

68. **Sprays, Their Mixing and Compatibility of Various Combinations,** R. H. Robinson.

Recommendations are made in this circular of methods for the mixing of various sprays and combinations of spray materials whereby injury from chemical reactions is reduced to the minimum.

69. **O. A. C. Portable Poultry Fence,** Frank L. Knowlton.

70. **Cutworm Control in Oregon,** B. G. Thompson.

A brief popular account of the cutworm and methods of control.

71. **Cherry Fruit-Fly,** Don C. Mote (Reprint of Agricultural Experiment Station Circular 35).

A brief description of the maggot and adult fly is given, followed by recommendations for control under Oregon conditions.

72. **Tree Borers and Their Control,** Don C. Mote (Reprint of Circular 39).

This circular states that fruit tree borers in general attack successfully only devitalized trees. The following are discussed briefly with control recommendations: flat-headed borer, shot-hole borer, bronze apple-tree weevil.

73. **Cankers of Apple and Pear in Oregon and Their Control,** S. M. Zeller.

This circular describes in a popular way ten different cankers and offers suggestions for their control. To aid in their identification a key is added with illustrations in the text. The ten cankers are apple-tree anthracnose or black spot canker, perennial canker, frost canker, fire or pear blight, European canker, black-rot canker, Cystospora canker, superficial bark canker, coral-spot disease and heart-rot canker. A paragraph is devoted to the treatment of wounds.

74. **A Survey of Marketing Problems Confronting Oregon Creameries,** D. L. James and N. C. Jamison.

This circular discusses trend of the dairy industry, cooperative methods of marketing employed by producers in some sections, conditions in

the butter industry, types of creameries in the state, competition for raw material, the bases of price on cream and butter, present market practices and outlets, previous experience of creameries in cooperative marketing and other topics. Recommendations are given for improving the situation.

75. **Studies Relating to the Harvesting of Italian Prunes for Canning and Fresh Fruit Shipment,** Henry Hartman.

This circular deals with the factors relating to the quality of Italian prunes picked for Eastern shipment, such as time of picking, determination of maturity in which the sugar test and pressure test are compared. The circular also discusses the time of picking in relation to canning quality and touches briefly upon diseases of prunes in storage.

76. **Apple Thinning in Hood River Valley,** Gordon G. Brown.

Results of two apple thinning experiments are presented briefly as a guide in thinning to assist in developing desired sizes in fruit.

JOURNAL OF AGRICULTURAL RESEARCH

The Cause and Control of Yellow Berry in Turkey Wheat Grown Under Dry-Farming Conditions, by J. S. Jones and G. A. Mitchell, published in Vol. 33 No. 3. Journal of Agricultural Research.

Spreaders for Spray Materials, and the Relation of Surface Tension of Solutions to Their Spreading Qualities, by R. H. Robinson, published in Vol. 31 No. 1. Journal of Agricultural Research.

Further Studies of Potato Wilt Caused by Verticillium alboatrum, by M. B. McKay, published in Vol. 32 No. 5. Journal of Agricultural Research.

A Blossom and Spur Blight of Pear (*Pyrus communis*), Caused by a Strain of *Botrytis cinerea,* by S. M. Zeller published in Vol. 33 No. 5. Journal of Agricultural Research.

The Brown-pocket Heart-rot of Stone Fruit Trees Caused by *Trametes subrosea,* Weir, by S. M. Zeller (In press). Journal of Agricultural Research. Vol. 33 No. 7.

TECHNICAL PAPERS

Mineral Metabolism Studies With Dairy Cattle. (2) Mineral Equilibrium After Prolonged Lactation, by H. G. Miller, W. W. Yates, R. C. Jones, and P. M. Brandt. American Journal of Physiology. Vol. 72 No. 3.

Mineral Metabolism Studies With Dairy Cattle. (3) Mineral Equilibrium During Gestation, by H. G. Miller, W. W. Yates, R. C. Jones, and P. M. Brandt. American Journal of Physiology, Vol. 75 No. 3.

The Relation of Natural Foodstuffs and Their Treatment on Growth and Reproduction, by H. G. Miller and W. W. Yates. The Journal of Biological Chemistry, Vol 62, No. 1.

Potassium in Animal Nutrition 111 Influence of Potassium on Total Excretion of Sodium, Chlorine, Calcium, and Phosphorus, by H. G. Miller. The Journal of Biological Chemistry. Vo. 67 No. 1.

Is the Beef Steer an Economical Producer of Meat? By E. L. Potter, published in The Producer.

Reducing the Cost of Cattle, by E. L. Potter, published in Breeders' Gazette.

Experiments in Growing Cattle, E. L. Potter, published in Western Breeders' Journal.

Raising Sheep on Logged-off Land of Western Oregon, by E. L. Potter, published in Western Breeders' Journal.

Fattening Lambs for the Late Winter Market, by E. L. Potter published in Western Breeders' Journal.

Blow Flies, by O. M. Nelson, published in Oregon Wool Grower.

Home Curing of Pork, by A. W. Oliver, published in Western Breeders' Journal.

The Blackcap Industry in the Pacific Northwest, by W. S. Brown, published in the American Fruit Grower May and June, 1925.

Economic Studies of the Pear Industry, by W. S. Brown published in Oregon State Horticultural Society Report, December, 1925.

Determining Maturity in Deciduous Fruits, by Henry Hartman, published in Report of Oregon State Horticultural Society.

Studies Relating to the Harvesting and Storing of Bosc Pears from the Rogue River Valley, by Henry Hartman, published in Report of Oregon State Horticultural Society.

Studies Relating to the Handling of Sweet Cherries, by Henry Hartman published in the American Society of Horticultural Science.

Harvesting and Processing of Sweet Cherries, by Henry Hartman, published in The Canner, February, 1925.

Standardizing Hydrometers and Thermometers, by E. H. Wiegand, published in The Canner.

Cherry Pollination, by C. E. Schuster published in Better Fruit.

The Trend of the Nut Industry, by C. E. Schuster, published in Better Fruit. January 1925.

Nut Growing in Oregon, by C. E. Schuster published in the Report of the State Board of Horticulture, February 1925.

Pedigreed Nursery Stock, by C. E. Schuster, published in the American Fruit Grower.

Growing Filberts in the Pacific Northwest, by C. E. Schuster, published in the American Pomological Society Bulletin.

Recent Development in Electric Brooding, by George W. Kable, published in Journal of the American Society of Agricultural Engineers.

Results of Research in Feed Grinding, by George W. Kable, published in the Journal of the American Society of Agricultural Engineers.

A Suggestion as to How Phytophagous Insects May Ingest Powdered Poison, by Joseph Wilcox, published in Jour. of Economic Entomology Vol. 19, Feb. 1926.

Observations on *Syneta albida* Leconte in Oregon and Experiments on Its Control, by Joseph Wilcox published in Jour. of Econ. Ent. Vol. 18, pp. 686-689.

The Gooseberry Root Borer, (*Xylocrius agassizii* Lec.) by W. J. Chamberlin published in Jour. of Econ. Ent. Vol. 18 Oct. 1925.

A Frame Eyeleting Machine, by H. A. Scullen published in American Bee Journal, March 1925.

Strawberry Leaf Roller Again, by Don C. Mote published in The Oregon Farmer, June 1926.

Look Forward Now to Next Year's Honey Crop, by H. A. Scullen, published in The Oregon Farmer, October 1925.

Beetle is Probably at Work, by Joseph Wilcox, published in The Oregon Farmer.

1925 Revised Spray Program, by Don C. Mote and H. P. Barss, published in Better Fruit, February 1925.

A Few Fundamentals in the Management of Bees, by H. A. Scullen, published in The Oregon Farmer, February 1925.

Methods of Controlling the Pesky Pests, by Don C. Mote, published in Better Fruit, March 1926.

Bees Need Strong Colonies for Pollination of Plants, by H. A. Scullen, published in Pacific Homestead April, 1926.

Wire Worms in Gardens, by Don C. Mote, published in The Oregon Farmer. May 1925.

Make Bee Colonies Stronger for Spring Orchard Work, by H. A. Scullen, published in the Pacific Homestead, February 1925.

Spray for Fruit Blister Mite, by Don C. Mote published in Oregon Farmer. April 1926.

Kill Dried Prune Weevil, by Joseph Wilcox, published in Oregon Farmer. July 1925.

Against Slugs and Cutworms, by Don C. Mote, published in Pacific Homestead.

Give Bees a Chance if You Want a Honey Crop, by H. A. Scullen, published in Oregon Farmer. April 1925.

Another Lead Boring Beetle, by W. J. Chamberlin published in Jour. of Econ. Ent. Vol. 17 No. 6.

Ladybugs vs. Aphis, by Don C. Mote published in Pacific Homestead. May 1926.

Contributions to Our Knowledge of Oregon Fungi 11. Mycological Notes for 1925, by S. M. Zeller (In press) Mycologia.

Species of Nectria, Gibberella, Fusarium, Cylindrocarpon and Ramularia Occurring on the Bark of Pyrus spp. in Oregon, by S. M. Zeller (In press) Phytopathology.

Phoma Mali Schulz Et Sacc, as the Cause of Apple Canker in the Pacific Northwest, by S. M. Zeller, (In press) Plant Disease Survey Reporter.

Observations on Infections of Apple and Prune Roots by *Armillaria mellea* (Vahl), by S. M. Zeller (In press) Phytopathology.

A Case of Verticillium Wilt (Blue Stem) of Black Raspberry in Oregon, by S. M. Zeller, Abstract—Phytopathology 15:125,1925.

Some Facts About Blackberry Dwarf, by S. M. Zeller, Abstracted Phytopathology 15:125,1925.

Another Apple-Tree Anthracnose in the Northwest, and a Comparison With the Well-Known Apple-Tree Anthracnose, by S. M. Zeller and Leroy Childs. Abstracted—Phytopathology 15:728,1925.

Preliminary Report on Transmission of Dwarf in Loganberry, by S. M. Zeller. Abstracted—Phytopathology 15:732,1925.

Value of Lime for Legumes on Acid Soils, by W. L. Powers published in Oregon Countryman.

Factors Affecting Feasibility of Reclamation Projects, by W. L. Powers published in Oregon Reclamation Congress.

Water Requirements of Pears, by W. L. Powers published in Bien. Rept. Or. Hort. Soc.

Supplemental Irrigation for Willamette Valley, by W. L. Powers, published in the Oregon Statesman.

Reclamation and Land Utilization, by W. L. Powers, published in Oregon Rec. Congress Quarterly Letter.

Irrigation Investigations in Rogue River Valley, published in Southern Oregon Press.

Effect of Fineness of Grinding on Rate of Oxidation of Sulfur, by R. E. Stephenson, published in Soil Science.

A Simple Method for Comparing Acidities of Different Ph Values, by R. E. Stephenson, published in Journ. of Amer. Soc. of Agronomy.

The Effect of H + Concentration on Growth of Certain Plants, by W. L. Powers published in Western Soc. Soils Science, 1926.

A Study of the Colloidal Fraction of Certain Soils Having Restricted Drainage, by W. L. Powers published in A. S. A. E. Tahoe Meeting.

Studies With Sulphur in Relation to the Soil Solution, by W. L. Powers. Doctor's Thesis.

Soils of Eastern Oregon, by W. L. Powers published in U. P. R. R. Pamphlet.

Strip-Border Irrigation for Sandy Soils, by W. L. Powers, A. S. A. E. Comm.

Experiments in the Reclamation of Alkali Land, by W. L. Powers published in Pacific Homestead.

Oil Emulsions, by R. K. Norris, published in Oregon State Horticultural Society Report, December 1925.

Value of Bordeaux Mixture in Blight Control, by F. C. Reimer, published in Oregon State Horticultural Society Report, December 1925.

Pear Stock, by F. C. Reimer published in the Oregon State Horticultural Society Report, December 1925.

POPULAR ARTICLES

Several hundred popular articles were published in journals, magazines, and newspapers.

RESULTS OF INVESTIGATIONS UNDER WAY

THE main investigations under way during the biennium are reported on briefly on the following pages. The reports by departments and branch stations are largely as prepared by the respective department heads and Station superintendents. Full credit to staff members is hereby acknowledged.

DEPARTMENT OF ANIMAL HUSBANDRY

HORSES

In work with horses, studies of the cost of horse-power on the farm were continued. Tabulated records are kept of cost of feed, shoeing, harness depreciation and repair, bedding, and labor for feeding and care.

BEEF CATTLE

All work in wintering stock cattle and with fattening steers is conducted at Union. Work at the Home Station has been along the line of cost of growing pure-bred heifers to breeding age. This study has not been carried far enough to give results.

HOGS

Protein feeds. The tests on the value of protein feeds fed with barley showed: (1) that mill-run was not a very satisfactory protein supplement; (2) that a combination of middlings and tankage was better than tankage alone; and (3) that a combination of alfalfa leaves and tankage gave fair results, but was inferior to either tankage alone or a combination of middlings and tankage.

It required three times as much horse-beans as tankage to balance a ration and even this amount did not give as good results as tankage. Horse-beans are, however, a satisfactory source of protein when the fact that they can be raised on the farm is taken into consideration, thus eliminating the necessity of buying high-priced protein feed.

Rye. In tests comparing rye with barley for fattening pigs, the gains on the rye ration were 31 percent less and cost 4 percent more than those on the barley ration. Because of a difference in palatability it was impossible to get the pigs to consume as large a ration of the rye as of barley. Both the rye and barley in these tests were balanced with 6 percent tankage.

Rape pasture. An acre of rape replaced approximately 1200 pounds of grain for fattening pigs. Pigs on self-feeder supplemented with rape pasture gained faster than pigs self-fed in dry lot. In growing tests, pigs made satisfactory growth on rape when fed two pounds of grain per 100 pounds live weight and were in good, thrifty condition to be fattened in the feed lot.

Preparation of grain for growing and fattening pigs. In two tests comparing whole dry, whole soaked, coarse ground, fine ground, and steam rolled barley, it was found that for fattening pigs these feeds ranked as follows: First, steam rolled barley; second, finely ground barley; third, coarsely ground barley; fourth, whole soaked barley; and, last, whole dry barley. Whole barley either dry or soaked did not prove to be a satisfactory feed for fattening pigs, as they did not consume enough to make satisfactory gains. As steam-rolled barley can not be produced on the farm, it would seem as though finely ground barley would be the most advisable under general farm conditions.

The best preparation of oats for growing pigs has not as yet been determined. The results of two tests were contradictory.

Cull apples for hog feed. These experiments were conducted to determine the feeding value of cull apples. The first tests did not give very satisfactory results as for some reason or other the daily gains were very low. In a second test, however, a lot fed 3 pounds of apples to 1 pound of grain gained 1.4 pounds per day per pig. The amount of apples required to replace 100 pounds of grain varied from 400 to 900 pounds.

SHEEP

Breeding efficiency of ewes. Investigations into the breeding efficiency of ewes and factors affecting that effciency were initiated four years ago and are still in progress. The investigation was first directed

toward determining the influence of condition upon breeding efficiency. Results so far obtained indicate that a high condition in breeding ewes is rarely a cause of low breeding efficiency, but, on the other hand, is often the result of barrenness. The positive causes of low breeding efficiency have not yet been discovered. The problem is a large one and it may never be solved. It is believed, however, that the vigor of the ram, the management of the flock at breeding time, and the general health of the ewes are strong contributing factors. In the last few years, the percentage of dry ewes in the college flock has been reduced from 30 percent to 4 percent.

Pasture yields for farm sheep. This is a continuation of work started several years ago to determine the yield per acre and the value of clover, rape and clover, drilled rape, vetch, rye-grass, and native sod pastures for Willamette Valley sheep. Because of crop failures, we have been unable to gather data on either the rape or the rape and clover pasture during the past biennium. Our native sod pastures have been yielding from 200 to 300 sheep days per acre, depending on the season. During the past biennium rye-grass pasture has been yielding 400 to 500 sheep days per acre. On a cost basis, the native sod has been the cheapest. Native sod is not satisfactory, however, for summer pasture for lambs.

During the past year, work was started on irrigated pasture. The seeding is new and as yet no results have been obtained.

Spring pasturing of Hungarian vetch has postponed the harvesting of the hay crop and improved the quality of hay produced. It has, however, reduced the yield of hay. On areas grazed as late as the first of May, each sheep day of pasture has reduced the yield of hay six to eight pounds. Vetch intended for hay can be moderately grazed with sheep early in the spring without materially lowering the yield of hay.

GOATS

Land clearing with goats. This work started in 1924 and is to determine the best methods of killing different types of brush with goats. Results so far show that in order to kill brush it is necessary that the goats be confined closely and that the brush be severely overgrazed, so much so that it is necessary to have other feed or pasture for the goats than the brush they are supposed to clear. It has so far been shown that the goats will eat every vestige of green growth on practically all of the native deciduous shrubbery and conifers of the Willamette Valley. Of the brush on the college farms, the goats show the least preference for poison oak and Scotch broom. In fact, they had to be starved to it. One year's browsing killed the conifers, but did not kill any of the deciduous shrubs. On some of the lots the brush was slashed before being browsed and on others it was not slashed until browsed. It was found that slashing was much easier with the latter method, as it was then unnecessary to slash any brush less than five feet in height.

COST OF PRODUCTION

Cost-of-production studies which have been in progress more or less continuously for the past ten years have reached a point where publications have been possible. During the last biennium Station Bulletin 219, Cost of Producing Mutton and Wool on Eastern Oregon Ranges, and Station Bulletin 220, Cost of Producing Beef on the Ranges of Eastern Oregon, and Station Circular 62, Cost and Profits of Sheep on Irrigated Farms, have been published. A bulletin on Cost of Producing Sheep in Western Oregon is about ready for the press.

ELECTRICITY ON THE FARM

Hay hoisting. Complete data on the amount of electricity and the time required for hoisting hay have been obtained. These data have not been correlated at present. It is believed that the results of the hay hoisting work indicate that the most desirable type of hoist is one having two drums, one for the pull-up cable and the other for the pull-back cable. These two drums should be geared so that the two cables travel at approximately the same speed. From a practical standpoint, it was found that the pull-back cable should not travel much faster than the pull-up cable, as too much speed in the pull-back cable jerks and jams the hay carriage too much. The results further show that the power hoist will not put the hay into the barn much faster than a team will, but by using the hay hoist, one team and one man can be eliminated from the hay crew. This test also includes the testing of different types of hay forks. The grapple type of hay fork proved to be more satisfactory than other types of forks, especially when it is used with a power hoist, which makes it possible to lower the fork as the man sets it. Otherwise, with a horse-hoisting outfit, the grapple fork would not be very desirable, as it is too heavy for one man to handle.

Feed grinding. During the last year work has been started studying power requirement and efficiency of various types of mills. These data as yet have not been correlated. The different types of mills that are being used in this study are the hammer type, the burr type, and the roller type.

The hay hoisting and feed grinding tests are being conducted in cooperation with the Agricultural Engineering department on the project of "Relation of Electricity to Agriculture."

DEPARTMENT OF DAIRY HUSBANDRY

The department of Dairy Husbandry is responsible for the development of all experimental studies bearing directly upon the dairy industry, although many of the problems are studied in cooperation with other departments. The pathological phases of the abortion disease problem are handled entirely by the department of Veterinary Medicine, the department of Dairy Husbandry cooperating with its own herd of cattle and being responsible for the interpretation of results from the standpoint of dairy cattle management. The Dairy department developed the plan of making comprehensive studies of nutritional problems principally in-

volving the utilization of minerals. In this study the department of Agricultural Chemistry is cooperating, having charge of the analytical work and the interpretation of results from a chemical standpoint. The department of Dairy Husbandry, however, is responsible for the interpretation of these results and their adaptation to field conditions so far as they affect management of dairy cattle.

It is by this close cooperation that the more complicated problems that carry one into the field of physiology and pathology are being successfully studied.

MARKETING STUDIES

Marketing of butter. During the last year the Station has completed a study of the factors involved in the marketing of butter by Oregon creameries. This study is reported in Agricultural Experiment Station Circular 74, A Survey of Marketing Problems Confronting Oregon Creameries. The butter marketing situation in Oregon has not been satisfactory for many years. This study shows that there is a difficult task ahead for both the creameries and dairymen before satisfactory progress can be made.

Quality and standardization are altogether lacking. Butter is practically dumped on the markets. There is no satisfactory dairy produce exchange operating in Portland. Market quotations do not represent actual prices paid for butter or butter-fat.

Before satisfactory progress can be made, butter must be standardized and quality improved, and in some manner a more stable market must be created in Portland. Quotations must be more reliable so that they can be more confidently followed by the creameries located in the country. Efforts are already being made to bring about standardization and develop a sales organization. The Station contemplates further studies leading to a solution of the problem of standardization.

Milk marketing studies. In June, 1926, the Station started a comprehensive study of the milk marketing problems of Portland. Farmers selling milk in the Portland area are dissatisfied with the prices received for their product. Investigation shows that 79 percent of the milk sold by the pasteurizing plants is sold at wholesale prices. The bulk of the milk which reaches the Portland consumer is handled by two middlemen instead of one. It appears that much of the difficulty encountered by the retail dairymen is due to the influence of the retail store in the sale of milk.

Another serious difficulty encountered is the great fluctuation in the supply of raw milk. The farmers ship a surplus during April, May, and June, while in August and September their shipments fall off to the point where the demand is greater than the supply furnished by regular shippers. This compels the distributors to buy milk from cheese factories and condenseries during that period. The condition in this business appears to be one which has developed largely as a result of the system of selling the milk to the stores, which, in turn, pass it on to the consumer. The fluctuations in the supply may be due to the lack of pastures during the summer months, but there may be other factors re-

volving around the economics of herd management, which this investigation may not be able fully to explain. It is thought that as a result of this study it will be possible to make suggestions that both the distributors and producers can follow to their mutual advantage.

METABOLISM STUDIES

The object of this experiment on mineral requirements of growing cattle is to determine whether it is important or not to insure a rich supply of minerals in the rations of growing heifers. Twenty animals are to be used in the trial. These are to be divided into four groups of five animals each. All the animals will receive the same milk and grain treatment, but with various roughages and supplements as follows:

Group I—Alfalfa hay.

Group II—Cheat hay.

Group III—Cheat hay and bonemeal.

Group IV—Cheat hay, bonemeal, and cod-liver oil.

At the present writing (June 30, 1926), nineteen heifers have been placed on experiment, hence all the groups except one have the number of animals planned. Each group has one Jersey, one Guernsey, and two Ayrshire animals. Only two Holsteins being available, the groups are being completed with Ayrshires. Results on the oldest calves for the first six months indicate that cheat hay alone is not sufficient as a roughage for growing heifers. Gnawing of the boards in the stall and poor growth are the indicating symptoms.

Digestion trials. A digestion trial with alfalfa hay was made on two cows in the metabolism stalls with unexpected results to be reported under the Agricultural Chemistry department. The same two cows were later put in the stalls for a digestion trial when alfalfa hay was supplemented by starch. The results of the above are now being checked by using two different animals in the stalls.

STUDIES WITH ALFALFA HAY

The digestion trials with alfalfa hay and with alfalfa hay plus starch have been mentioned above.

In 1925 a feeding trial was made comparing Central Oregon and Willamette Valley alfalfa hay. Eight cows were used in the trial, which was carried on for a period of 342 days. Four cows were placed in each group, of which three animals received hay as their only feed, while the fourth received corn silage in addition to hay. The hay feed in this trial was long hay, of which the cows were fed all they would consume. Accurate records of milk and butter-fat production, weights of animals, and feed consumed and refused were kept.

The results may be briefly summarized as follows:

CENTRAL OREGON ALFALFA GROUP

No. of cow	Hay consumed	Hay refused	Milk produced	Butter-fat produced	Gain or loss in weight
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*
456	10,240.5	458.5	4,016.0	148.68	x 57
459	9,498.5	822.8	4,810.3	181.24	x 103
623	9,873.8	702.3	2,558.3	117.94	x 52
Total 3 cows	29,612.8	1,983.6	11,384.6	447.86	x 212

WILLAMETTE VALLEY GROUP

No. of cow	Hay consumed	Hay refused	Milk produced	Butter-fat produced	Gain or loss in weight
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*
424	9,961.3	651.3	4,957.6	171.66	x 16
457	10,129.8	616.3	3,806.7	142.38	x 15
462	9,909.0	650.0	3,568.5	123.98	x 106
Total 3 cows	30,000.1	1,917.6	12,332.8	437.92	x 137

The results show practically no difference in two kinds of hay; if anything the Central Oregon hay was a little superior, as a little less hay produced more butter-fat and maintained the cows better. On the other hand, the Willamette Valley group produced slightly more milk. The significant thing about the results is the low production of all the cows. The cows consumed an average of 30.54 pounds of alfalfa a day from which they produced during their lactation period an average of 3952.9 pounds of milk and 147.63 pounds of butter-fat. This compares very unfavorably with the production of 300 to 450 pounds of butter-fat per year claimed by many dairymen feeding only alfalfa hay. The discrepancy can hardly be due to better cows, as several of the cows used in the test have demonstrated their ability. For example, cow 623 has an A. R. yearly record as a two-year-old of 9,769.4 pounds of milk and 622.74 pounds of butter-fat. The latter record nearly approximates the total yearly butter-fat production of the six cows on alfalfa hay.

As indicated above, one cow from each group received corn silage in addition to alfalfa hay. These two cows, which were Holsteins, consumed about 30 pounds of alfalfa hay and 20 pounds of corn silage per day. They averaged 5,452.1 pounds of milk and 185.56 pounds of butter-fat in their lactation period. This is far below their proved capacity under regular dairy herd conditions. It is, however, somewhat better than the production of the cows on alfalfa alone.

Beginning with January 1, 1926, several changes were made in the plan of the investigation. Two more cows were added, one to each group, while another animal, No. 216, was replaced due to the development of an abscess in her foot. The main change in the plan was to feed chopped hay in place of whole hay. The data so far accumulated show a greater hay consumption, less waste, and a larger milk and butter-fat production. Whether these advantages will continue in a great enough measure to affect the cost of chopping remains to be determined.

The plan is to continue the cows on a chopped hay throughout the present year, when the alfalfa hay will be supplemented with grain, or with grain and pasture. The data accumulated from the digestion trials should give information as to the grain supplement required.

STUDIES ON THE FEEDING OF SUCCULENTS

Kale vs. corn silage as a source of succulence in the ration of lactating cattle. A trial was made in the fall and winter of 1925-26 comparing kale and corn silage as sources of succulence for milking cows. Twelve cows were used in the trial. These cows were divided into two comparable groups of six cows each, and the trial run by the double reversal method, that is, Group A was started on corn silage, continued for 28 days, changed over a period of seven days to kale, continued on kale for 28 days, changed over a period of 7 days back to corn silage and continued on corn silage for another 28 days. Group B was started on kale, changed to silage, and then back to kale. The hay and grain were kept the same throughout the test.

Briefly, the results are as follows:

Group	Pounds corn silage	Pounds milk	Pounds butter-fat	Pounds gain or loss in weight	Pounds kale	Pounds milk	Pounds butter-fat	Pounds gain or loss in weight
A	4,060	3,912.2	160.67	x 8	4,536	4,028	172.34	x 146
B	7,864	3,963.9	177.54	x 106	9,137	4,206.8	184.78	– 26
Totals	11,924	7,876.1	338.21	x 114	13,673	8,234.8	357.12	x 120

The results show that kale has a value beyond what would be expected from a dry-matter analysis.

Economical feeding of succulents. It will be noted that Groups A and B were fed on different planes of succulents, Group B being given about double the amount given Group A. The object was to determine the most economical amount of succulents to feed. The results clearly indicate that Group A, getting the lowest amount of succulents, were the most economical producers. This was true with both corn silage and kale. Group A animals received from 25 to 30 pounds of succulents per day, and Group B from 50 to 60 pounds. An attempt will be made to get more data on this point on a similar feeding trial with kale and corn silage in 1926-27, which should be made before the results should be published.

Effect of turnips on quality of milk and butter. Preliminary investigations to determine the effect of turnips on the quality of milk and butter were made in the spring of 1926 and are still being continued. Turnips are now being grown for further investigations during the coming fall and winter.

Effect of kale on quality of milk and butter. The effect of kale on the quality of milk and butter will be studied in conjunction with a feeding test to be conducted this fall. Popular belief is that kale imparts a feed flavor to milk, but a preliminary investigation carried on by this Station in 1913 indicates that such is not the case.

Pasture investigations. Data on carrying capacity of pastures are being collected in cooperation with a number of dairymen. Nine farmers are cooperating in the Willamette Valley, and plans are under way for tests at the Station at Corvallis and the Branch Station at Astoria.

Clover, alfalfa, grains, and grasses are under study. As far as practicable the economic possibility of irrigating pastures will be tested.

NORMAL GROWTH STUDIES

In order to add to data already published from the Missouri Station on the normal growth of Jersey, Holstein, and Guernsey heifers, measurements are being taken every month of all females in the herd up to the time of calving. In the case of Ayrshires, no data have been published, and as our data are extensive with this breed it is planned to publish a statement of the results during the present year for use in nutrition experiments with growing cattle and for their value to the breeder of pure-bred cattle.

DIFFICULT BREEDING OF HEIFERS

In order to obtain data on the general prevalence of this disorder, a questionnaire has been circulated among several experiment stations in different sections of the country. The answers so far received indicate considerable difficulty along this line. Another questionnaire will be sent this fall to prominent breeders as indicated by the various experiment stations. Analysis of data obtained from the questionnaires should give us information as to the prevalence of the difficulty in various regions and whether it is correlated with the feed or environmental conditions.

At the present time four animals which have failed to breed are being fed cod-liver oil to determine whether an excess of Vitamin A will be of benefit to dairy cattle, as it is in the case of small laboratory animals.

ABORTION INVESTIGATIONS

These investigations are in cooperation with the Veterinary department, which will report progress of the investigation. One animal in the dairy herd aborted during the year. She was isolated and reacted slightly positive to the blood test, hence she was sold to the Veterinary department for experimental purposes. Eight calves from the veterinary herd have been brought to the dairy herd during the year. They were isolated for three months, and as they all reacted negative to the blood test no further special precautions were taken. No bad results have followed the using of the dairy herd bulls on the abortion herd cows.

EFFICIENCY OF HERD SIRES

This project is in cooperation with the Veterinary department, and is reported by that department. Examination of the semen of various bulls has been made when convenient at the various services. The bulls

have been kept in only a fair condition of flesh and exercised whenever possible. All bulls except the Holsteins are exercised on the tread power, the Holsteins being allowed to run in the paddock.

Oregon Peter Pan and Cacapon Major Douglas, the Ayrshire herd sires, proved themselves about 90 percent efficient in service. Oregon Pontiac Jerome, the Holstein sire, was only 50 percent efficient. This may be correlated with the lack of sufficient exercise in the paddock, since he was bred, for the most part, to mature cows. The Jersey bull, The Maoris Hector, likewise has only been about 50 percent efficient. In his case the trouble may have been due to the heifers to which he was largely bred, and which came along at the end of the winter season.

PROVED SIRE PROJECT

This project is being carried on in cooperation with the U. S. Dairy Bureau. The object of the experiment is to use for generation after generation sires that have proved their ability to transmit high milk and butter-fat producing capacities, for the purpose of breeding cattle that will be pure in their inheritance for high milk and butter-fat producing capacities.

The Holstein breed of cattle will be used in the experiment. The Holstein bull Colantha Pontiac Hero, 277647, was shipped from the U. S. Government Experimental Farm at Ardmore, S. D., to the College on October 28, 1925. He became lame on the trip and could not be used until April, 1926. Since that time, however, ten cows have been bred to him. He will be used on all cows in the Holstein herd in preference to Oregon Pontiac Jerome, the other herd sire, who will probably be disposed of.

ECONOMICAL VEALING OF CALVES

The limiting factor in the vealing of calves is the high cost of whole milk and the inability to find a satisfactory substitute. It has been shown that calves grow very well on skim milk, cod-liver oil, grain and hay after a start of about 30 days on whole milk. This suggests the possibility of substituting cod-liver oil for the butter-fat in whole milk when removing the calves from their dams. Cod-liver oil can be purchased at a price that makes the fat about 18 cents per pound. With butter-fat at 40 cents per pound or more, this would be a considerable saving. Preliminary steps along this line have been taken. Six non-valuable bull calves have been given skim milk and cod-liver oil since about four days of age. So far the results have not been very satisfactory in so far as vealing the calves is concerned, but the calves are making good growth. The investigation will be continued, and if unsatisfactory with cod-liver oil other supplements will be tried.

OFFICIAL TESTING

Each year a mimeographed bulletin has been issued giving the National and Oregon Class Leaders in all divisions of the various breed classifications of records. Besides these bulletins, four studies were made as follows:

(1) A study of the one-day versus the two-day Official Test. In this study 95 completed yearly records were examined in detail to ascertain the feasibility of substituting a one-day test period in place of the two-day test period. The following results were obtained:

a. The two-day test gave an average fat production of 491.74 lbs.

b. The one-day test period gave an average fat production of 492.80 lbs.

c. Many records checked to the pound of fat production in both one-day and two-day test periods.

d. From a practical standpoint, the one-day test period is just as effective and reliable as the two-day period; the larger the number of records studied the more nearly the comparisons approach each other.

(2) A study of the estimated versus the actual milk weights as reported by the breeders in Official Testing. The purpose of this study was to see whether there is any decided variation between actual milk weights reported by the breeder and what should be produced by the animal as indicated by her official days' production. In other words, the purpose was to find out whether there is a systematic padding of milk weights by the breeder. One hundred and fifty-five completed 305- and 365-day records were studied. The results follow:

a. The average variation between the actual milk reported and the estimated milk that should have been produced was only 3.79 percent more actual milk that estimated milk.

b. Since a 5 percent variation is not considered out of bounds, the study indicates that Oregon records are not being padded.

c. Of the actual milk reported, 77.4 percent was within 3 percent of the estimated milk, and 89.6 percent of the actual milk reported was within 5 percent of the estimated milk.

(3) A study as to the necessity of the preliminary milking. The matter of whether a preliminary milking is an essential precaution to Official Test work caused this study to be made. One hundred completed yearly records were studied both as a preliminary milking group and also as a non-preliminary milking group. The results of this study show that:

a. When the preliminary milking is used the average production is 515.30 pounds fat and when the preliminary milking is eliminated the average production is 515.83 pounds fat.

b. From a practical standpoint, as far as effect is concerned, the preliminary milking is not necessary.

(4) Directory of sires with producing daughters in Oregon. This is purely a statistical project. Due to a large number of inquiries for a list of producing daughters of various sires in this state, and also due to the desire to see how the various lines of breeding in the state were developing as shown by the official records, this directory has been compiled.

DAIRY BULL REGISTRATION BOARD

In the administration of this law, which was passed in 1921 and amended in 1923, 498 animals have been licensed for sale during the biennium. The difficulty of getting evidence of violations of the law sufficient for prosecutions continues to be one of the drawbacks of this law.

DEPARTMENT OF POULTRY HUSBANDRY

BREEDING TO EXTEND THE PROFITABLE AGE OF THE DOMESTIC FOWL

The results are now available on four generations of Single Comb White Leghorn and Barred Plymouth Rock pullets involved in this experiment. The foundation stock originally selected for this experiment was that which has been bred up for first year production in the previous breeding experiment, "Inheritance of High Production." It has been possible to increase the first-year egg record required of a bird from 180 to 200 before she is admitted to the breeding pens. No female of either breed which has not laid at least 200 eggs in her first year has been used as a breeder during the past two years. Ultimately it is hoped to raise this requirement to 225 first year, 200 second year, 175 third year, and 150 fourth year.

From the beginning it was recognized that very rigid culling would be necessary in order to eliminate from the flocks these individual hens which were low in egg weights or body weights. A definite standard has been set each year for both weights and all hens marketed that failed to reach such standards. The standards have been raised slightly each year and the number of hens that it has been necessary to eliminate from each generation because of failure to attain these standards has decreased slightly each year. This is taken as an indication of progress. The standards used for the fourth generation of pullets (1925 hatch) when they were weighed in March, 1926, were as follows:

	Body weight	Egg weight per dozen
	lbs.	*oz.*
Barred Rock	4	20.25
White Leghorn	3½	21.50

The application of these culling standards has made the strains much more uniform in appearance and has increased the percent of Barred Rock pullets laying standard eggs (22 ounces per dozen) by about 12 percent per generation. The Leghorn egg weight has increased only very slightly, but was sufficiently high in the first generation so that very little culling was necessary on that point alone.

Early laying maturity in relation to good laying. Additional data being accumulated but no tabulations made therefrom.

Relative influence of sire and dam on offspring. Additional data accumulated but no tabulations made therefrom.

Breed improvement. More data accumulating since in our main project we are culling on defects like side sprigs, stubbs, etc., and also on body weight, egg weight, broodiness, egg records, and hatchability. No attempts have recently been made at tabulation.

Miscellaneous. The Poultry department has continued its policy of distributing hatching eggs and pedigreed male birds to residents of the state at a nominal price. The effect of this policy has been to raise the average production of the state's flocks to considerably above that of the average for the country.

The College radio station, KOAC, has broadcast fifteen poultry lectures during the past year. Much of the material used in these lectures was based either wholly or in part upon the work of the Agricultural Experiment Station Poultry department. It is proposed to give eighteen poultry radio lectures during the coming year on breeding, feeding, and management, and six additional lectures on poultry diseases. The breeding lectures will in a large measure be based upon the Station's work in breeding to increase egg production, and to extend the profitable age of the fowl.

The south poultry farm has been reorganized during the past three years, and particularly during the past two years. With new driveways, together with the erection of suitable fences forming permanent yards, and also with the building of pullet laying or testing houses, it has been possible to carry on the work much more efficiently than was true formerly.

DEPARTMENT OF VETERINARY MEDICINE

INFECTIOUS ABORTION

Methods of spread of the disease. These studies have been discontinued with the exception of the relation of the bull to the spread of abortion. The use of negative bulls on both positive and negative cows has not resulted in the spread of abortion to the negative cows. These experiments are in accord with those previously reported.

One positive reacting bull was bred to three negative heifers. The heifers remained negative.

The relation of reinfections to subsequent abortions in abortion-infected cows. Infected cows, which have previously aborted, kept isolated in box stalls have usually carried their next calves full time. A considerable percentage of such animals standing in stanchions adjacent to recently aborting cows have aborted again. This indicates that reinfection probably is an important factor in second or third abortions.

Field observations seem to agree with this theory. Range beef cows and heifers, infected with abortion, usually abort only once and then the disease seems to disappear. This is true of some small dairy herds in which the cows are bred for calving at only one period of the year. In such herds the typical course of the disease is as follows:

1. Introduction of infection through the introduction of an infected cow or heifer which aborts, thus exposing all other pregnant animals.

2. Abortions in a high proportion (50 to 95 percent) of the pregnant animals.

3. A period of three months or more during which there are no pregnant animals and no aborting animals on the premises. During this time the amount of infection is very materially decreased through the action of natural agencies.

4. Breeding followed by only slight or perhaps no exposure to abortion infection. This condition is best carried out in the beef herd bred on the open range away from the feed lots in which abortions have occurred the previous winter.

5. Calving at full term. On the other hand, abortion is a very persistent disease in the average market-milk producing herd. In such a herd calves are being dropped every month of the year and there are pregnant animals in the herd at all times. Thus there is every opportunity for each aborting cow to reinfect some pregnant animal. In such herds the initial outbreak does not result in such a high percentage of abortion, but the disease persists and does a maximum amount of damage.

Further studies of the relation of reinfection to the course of abortion disease are being made. These should be completed in another two years.

Economic losses from infectious abortion. These studies have been continued. Data accumulated indicate an average decrease in production following infection of from 20 to 25 percent. This confirms previous reports.

Relation of age to the effects of abortion infection. Data covering 43 cows indicate that the younger the animal at the time of infection the more serious the results of the disease. These data are incomplete.

Establishment of abortion-free herds from abortion-infected herds. This work has been continued and progress has been very satisfactory. In the College herd only 4 abortions have occurred during the biennium as compared with 13 during the preceding biennium, and 25 during the biennium ending June 30, 1922. On the Hermiston project the percentage of reactors in all animals tested has decreased from 43 in 1922, when the first test was conducted, to 11 percent in April, 1926. In the nine herds which have been tested continuously the percentage has decreased from 51 to 9 percent. On this project no pressure has been brought to bear to influence owners of the reacting cattle to sell them. But their attention has been repeatedly called to the economic losses resulting from abortion disease and the possibility of eradicating it.

Some fifteen herds are now being handled cooperatively according to the plan previously outlined for the control and eradication of abortion. These are located in the following counties: Lane, Linn, Benton, Polk, Marion, and Washington. The percentage of reactors has varied from almost none to more than fifty in the various herds. Results are on the whole quite satisfactory. Provided the percentage of infected animals

is the same, it seems up to the present time that it is not more difficult to eradicate abortion than to eradicate tuberculosis.

RETAINED FETAL MEMBRANES

This study has been continued. Manual removal has given good results as reported previously.

STERILITY IN BULLS

Field studies in Tillamook county covering more than eighty bulls showed that approximately one-third of them were either sterile or fertile only a part of the time. Breeding tests with these animals agreed with microscopic findings in regard to sterility.

These studies proved it is practicable to make microscopic examinations of semen at the beginning of the breeding season and eliminate the sterile bulls. Such a procedure in the Tillamook district which was studied decreased the breeding troubles at least 50 percent according to the report of the practicing veterinarian in that county.

These studies will be continued.

STERILITY IN COWS

Very little work has been done on this problem. One outbreak of what seemed to be an infectious form of ulcerative vaginitis was studied. Field observations indicated that this was being spread by the bull. Bacteriological studies were inconclusive.

COCCIDIOSIS IN POULTRY

Preserving material for sporulation of oocysts. It has been shown that a 2 percent solution of potassium bichromate prevents putrefaction and at the same time does not interfere with either sporulation or longevity of oocysts. Sporulated oocysts kept moist with such a solution maintain their virulence for considerable periods, while those exposed to putrefactive processes lose their virulence rather rapidly. The use of potassium bichromate solution has made it possible to do quantitative experiments with infection.

The relation of the size of the dose to the results of the infection. There is a definite relation between the size of dose and the results of the infection. Small doses produce no clinical symptoms, while large doses produce symptoms and in many instances death in susceptible birds. These results are not in accord with statements from other laboratories studying coccidiosis.

The length of time following infection that birds will void oocysts in their droppings. Studies have shown that infected birds will usually cease voiding oocysts in 30 to 40 days.

The production of immunity against coccidiosis. Birds are being immunized against coccidiosis through the administration of gradually

increased amounts of the infection. A very definite immunity has been produced in this manner.

These studies are being continued.

Immunity of birds raised under commercial conditions on range. Inoculation experiments have demonstrated that birds raised on range under commercial flock conditions and management frequently acquire an immunity against coccidiosis. This is not the result of age. Since most commercial flocks are more or less exposed to coccidiosis, it seems that this immunity is probably the result of continuous exposure to small amount of infection.

The relation of lameness and paralysis to coccidiosis. Inoculation experiments with lame and paralyzed birds resulted in typical acute cases of coccidiosis. It is evident from these inoculations that these cases of paralysis were not the result of chronic coccidiosis as has been claimed by some research workers.

Bacillary white diarrhea. A sufficient number of birds were tested by the agglutination method to get data concerning the prevalence of this disease in Oregon poultry.

Chicken-pox. Experiments are under way with vaccinating against chicken-pox according to the method of De Blieck and Van Heelsbergen. These studies have not progressed far enough to draw any conclusions as yet and are being continued.

Cecal worms in poultry. Feeding experiments with embryonated eggs of *Heterakis papillosa* resulted in the production of mature forms in thirty days. This is a shorter time than is given by other investigators.

SALMON POISONING IN DOGS

Studies of this disease have proved the following:

1. Salmon poisoning is caused by a hitherto undescribed intestinal fluke which has been named *Nanophyetus salmincola* by Dr. Chapin of the United States Department of Agriculture, Bureau of Agricultural Investigations, Zoological Division.

2. The metacercaria of this parasite are found encysted in the kidneys, gills, livers, and muscles of eastern brook, rainbow, cutthroat, and mountain trout, and chinook, silverside, chum, and steelhead salmon. Metacercaria have not been found in bass, smelt, sturgeon, suckers, chub, and white fish.

3. These parasites occur in Northwestern California, practically all of Western Oregon and Southwestern Washington. They have not been found in fish from Northwestern Washington and from British Columbia.

4. They are not found in salt water fish.

5. They may be present in fairly large numbers in young fish before they are liberated from the hatcheries. It is possible that the parasites produce disease in fish.

6. The consumption of parasitized fish by dogs is followed by the appearance of a typical syndrome. Symptoms usually appear on the seventh day and death on the fourteenth day after eating parasitized fish.

7. Silver-black and blue foxes and coyotes are susceptible to salmon poisoning.

8. Satisfactory treatment of infested dogs has not been found.

9. Autopsy findings are typical. Microscopic studies of the duodenum reveal the parasites buried in the mucous membranes.

10. Salmon-poisoned dogs void large numbers of eggs of the fluke with their stools. A diagnosis of the disease can be made by finding these eggs.

11. Dogs which recover are immune. Attempts at producing immunity have not yet been successful.

12. Redia and cercaria have been found in large numbers in the snail *Goniobasis plicifera silicula* (Gould). These parasitized snails are very prevalent in streams where parasitized fish are found but it has not yet been proved that the cercaria being studied is the immature form of *Nanophyetus salmincola.*

MISCELLANEOUS STUDIES

Icter-hemoglobinuria in cattle. It was shown by use of antiserum obtained from the Nevada Experiment Station that the disease causing such heavy losses of fat steers in the Fort Klamath district is icter-hemoglobinuria as described by Vawter and Records of Nevada. Approximately 67 percent of the affected steers treated recovered. This antiserum is now being produced by one of the commercial biological companies.

Pernicious anemia in horses. This disease was diagnosed among horses in Wasco county. No experimental studies were made.

Stomach worms in sheep and goats. A species of stomach worm which had not been previously reported in Oregon was found in two bands of goats and at least four bands of sheep. These parasites were quite numerous and were undoubtedly causing serious disturbances in the host animals. A definite identification of the parasite has not yet been made.

Cysticerci in deer. Cysticerci of *Taenia krabbei* were identified in specimens from a deer killed in Douglas county. This constitutes the first report of this parasite attacking deer in this country.

MISCELLANEOUS SERVICE

The demands for this type of work continue to increase.

Laboratory diagnosis specimens are now received at an average rate of more than one per day.

Correspondence has increased about 40 percent over the preceding biennium.

Conferences with owners of livestock including poultry are requiring more and more time.

DEPARTMENT OF FARM CROPS

FORAGE AND SEED PLANTS

Investigations carried on cooperatively with the Forage Office of the Bureau of Plant Industry, of the Department of Agriculture, have been continued during the biennium, and include work with vetches and related plants, peas, clover, alfalfa, soy-beans, grasses, rape, kale, sunflowers, roots, and miscellaneous plants.

VETCHES AND RELATED PLANTS

Variety trials. The variety trial which includes the regular plot trials and a few nursery rows has been continued with the more important vetches, including Common vetch, Pearl vetch, and several new strains, *Vicia sativa;* Hungarian vetch, *Vicia pannonica;* Hairy, or Sand vetch; *Vicia villosa;* Woolly Podded vetch, *Vicia dasycarpa;* Purple vetch, *Vicia atropurpurea;* Monantha vetch, *Vicia monantha;* Tangier peas, *Lathyrus tingitanus*; Austrian winter field peas, *Pisum arvense*; and Bard vetch, *Vicia cracca.* These various vetches and related plants were grown with and without oats as a supporting crop.

Common vetch appears best for the well drained, moderately sweet soils. Its limitations are insufficient winter hardiness for some of the colder sections of the Willamette Valley, and susceptibility to aphis.

New early vetch. A new vetch, No. 13430, is early and apparently more resistant to aphis than the ordinary Common vetch. It is being multiplied.

Hungarian vetch has been very generally adopted in the Valley. It is more winter-resistant than Common vetch and is much more resistant to aphis. It is quite well suited to the heavier soils a little too poorly drained for Common vetch, and in some cases too acid for Common vetch. Rather too much has been expected of Hungarian vetch. It is not completely aphis-resistant. While more tolerant of water than Common vetch, it can be drowned out. It does not always make a good crop on sour, uninoculated soils. It does not seem as well suited to good upland conditions as Common vetch. A large number of people are using it, however, because it gives nearly the same returns as Common vetch, it produces a hay that is generally a little leafier, and it is distinctly better suited to the soils in some sections where conditions are not just right for Common.

The fact that Hungarian vetch seed is more readily eaten by livestock makes the screenings more desirable, and, in fact, offers a possible outlet for some of the seed. Trials show 60 to 80 pounds per acre a good rate of sowing.

Hairy vetch continues to find favor in the Eastern market, and a good many farmers are undertaking its culture. Experiments are being continued to determine the best time and rate of sowing the Hairy vetch for seed purposes. Yields vary from about three hundred pounds an acre to approximately a thousand pounds, under different conditions in the field.

Success with Hairy vetch involves getting a stand, getting it harvested without serious shattering loss, then getting it threshed and cleaned promptly, so that early boat shipments from Portland to the Southeastern States may be practicable. There is less desire for the seed if it must be handled so late as to be carried over into the next season.

Purple vetch continues to be grown in a number of places as a seed crop to be marketed in California. It is used as a cover crop and the demand is generally good at 5 to 7 cents per pound in Oregon.

Monantha vetch is attracting considerable attention in some sections and plans are under way for its multiplication. It has given good results as a seed crop in numerous years of the experiment, but lack of a tangible market for it has not justified increasing it heretofore. It appears to have promise as a cover crop in California and in the Southeast. Good seed yields are obtained on rather heavy soil.

Tangier peas are finding favor in a few sections in the southwest Coast District, where winter conditions are not quite so severe as in the Willamette Valley. The Tangier pea is probably a little too uncertain to justify recommending it as a fall planted forage crop for Willamette Valley conditions. The seed is large, sometimes hard, and generally expensive, which are other factors limiting its production.

Bard vetch (*Vicia cracca*) has attracted considerable attention in the Southwest. A quantity of seed was again obtained and put on trial. It failed to survive the mild winter of 1925-26. It had previously been dropped from the experiment.

Reports from California indicate that it is not in as good favor in Southern California for cover crop purposes as Purple vetch.

Woolly Podded vetch continues to make a satisfactory growth and to offer promise as a forage plant in some sections of the Coast District. Some inquiry comes from the Southeast for Woolly Podded vetch, but since there is no consistent market for it, there is little multiplication of it. It volunteers a little worse than Hairy vetch.

Horse-beans (*Vicia faba*), still look good. Experimental work has been exceedingly limited during the past biennium because of loss of seed stock by fire and by freezing.

VETCH ROTATION

The rotation continues to be interesting in its results. The yield of vetch continuously holds up rather well, and contrary to the theory expressed by many producers.

The most outstanding result is the tendency toward an accumulation of weeds in the continuous vetch plots.

FIELD PEAS

The Austrian winter field peas introduced in the fall of 1923 have made a remarkable showing. In the cold winter of 1924-25, they survived a temperature of about 8° below zero. They survived under conditions where Common vetch and the more tender vetches were killed. They showed as much hardiness as Hungarian vetch. These peas make a rank growth and produce many pods. They offer promise as a cover crop, a green manure crop, for silage, and as a crop to hog off. If they continue so desirable they will be of considerable consequence as a seed crop.

There are, however, two drawbacks to the Austrian winter field peas: (1) They are about as susceptible to aphids as Common vetch, since aphids work on them very extensively at certain seasons. (2) The seed is vigorously attacked by the pea weevil. This necessitates thorough fumigation immediately after threshing if the seed is to be marketable.

For general use, there is some doubt whether the seed may be produced as cheaply as that of Common or Hungarian vetch, but there may be a place for this on some of the soils that are rather sour for these vetches.

A number of inquiries have been received from the Southeastern States for this seed, but it cannot be determined at this time whether this is the result of promotion by the Department of Agriculture and county agents in the territory, or whether there is a real demand for quantities of it. Arrangements are under way for multiplying the crop.

CLOVER

Variety trial. Forty-four plots of various strains of Red clover and one plot of Alsike clover were grown in a clover variety trial. These included two lots of Oregon seed and a number of foreign and United States lots of clover furnished by Dr. Pieters of the United States Department of Agriculture. These were planted in 1923, and harvests were obtained in 1924 and 1925.

There was considerable difference in the survival the second year. Minnesota, Michigan, and Ohio strains had rather poor stands and yields the second year. The English strains, to a considerable extent, showed poor stands the second year.

The Chilean, Polish, and Australian lots were good yielders and held out well into the second year. Generally speaking, the North European and French varieties were good. The Italian varieties were poor yielders, even though the second year stands were generally good.

Alsike did not produce quite as much as most of the Red varieties. In the spring of 1926 the survival of these plots was so poor that it was not considered worth while to continue them.

Another planting of clover, made in 1924, failed. The work was continued with successful spring plantings in 1925 and 1926.

An interesting thing in connection with the Chilean seed was that it contained a considerable amount of alfalfa seed, and while planted on land considered wholly unsuited to alfalfa, the plants grew and survived, and were vigorous at the end of the experiment.

Some work is being done on the fall sowing of clover, as well as spring plantings, this having to do with the determination of the best method of obtaining a stand.

Clover breeding. Attempts are being made to select varieties of Red clover resistant to mildew and stem rot and to produce longer lived and higher yielding stands.

Crimson clover work is being continued. Where it may be planted and growth conditions are favorable, it appears to produce seed the first year. Where growth conditions are not favorable, it carries over into the second year for seed production.

Zigzag clover is being continued. Its perennial habit is emphasized and it shows great promise when it is possible to obtain seed. So far, seed yields have been insignificant and it is difficult to purchase it. All efforts in that direction have failed to date.

Yellow and white flowered sweet clover is being grown to a limited extent. There is considerable inquiry from farmers about it, due to Eastern publicity in general farm papers. It grows in a number of places in Western Oregon, but only to a limited extent, and except for some of the rather sweet soils in Southern Oregon, where drier conditions prevail, and for the soils in some of the irrigated sections of Eastern Oregon it is not recommended. It does not appear to be as valuable as alfalfa, vetches, Red or Alsike clover for hay, or Burr clover for pasture in Western Oregon.

Burr clover continues to show much promise in connection with pasture sowing for Western Oregon.

Ladino clover continues to grow and thicken up and reports from practically all sections of the state indicate great promise as a pasture clover for land that may be irrigated or that is slightly moist. Ladino clover has an inadequate seed supply and is rather too high priced for general use. Indications point to higher production and lower prices.

ALFALFA

There is a striking illustration of the survival of Grimm alfalfa over other strains in an old sowing on the east farm. Where good Grimm seed was used the survival is distinctly better than where other types were planted.

A strain trial consisting of Oregon grown Baltic and Idaho and Montana Grimm was planted in 1925 This included two lots of very good Montana seed, one lot of very good Idaho seed, one lot of No. 2

Idaho seed, and one lot of Oregon grown No. 2 Baltic. So far, little difference has been shown between the various lots.

The weed content of plots coming from seed with a widely different seed content showed but little difference in the field. Even on this land, which was sod for many years, and which was put into excellent seed condition, the difference in weed content of the various lots was not manifest, except by kind of weeds rather than by number. So many more weeds came from the soil than from the alfalfa seed that the difference was not noticeable.

Indications of stand are that the No. 2 seed was probably the most economical planted. *A rate-and-method* trial was started. Alfalfa was drilled at eight, twelve, and sixteen pounds per acre and broadcast at ten, fifteen, and twenty. Good stands were obtained in all cases, although the thicker sowings gave distinctly the thicker stands. Early in 1926, before the cutting of the first crop, the thick sowings were considerably thicker in appearance, but the thin sowings were slightly taller. The thick stands showed fewer weeds the first year. Observations are being made on the ability of one of the thick plantings to combat Canada thistle.

Cultivation. Continuation of the alfalfa cultivation experiment further indicates that there is little difference in the total yield between the cultivated and uncultivated alfalfa. In many instances the uncultivated alfalfa, being heavily infested with grass, produces somewhat more hay than the cultivated plots. The quality of hay from the cultivated plots, however, is much superior to that from the uncultivated ones.

Stem rot resistance and survival trials. On May 5, 1922, thirty-eight lots of alfalfa were planted in rows on land that had previously been in sweet clover and that was heavily infested with the disease of stem rot. In 1926 the survival of the alfalfa was noted.

These strains came from Ecuador, Argentina, Manchuria, China, India, Turkestan, Palestine, South Africa, Sweden, Italy, Spain, France, Russia, Canada, New Zealand, and from California, Arizona, and also included Grimm, Baltic and some of the hardy Common from the Northwest. The survival indicated that the Grimm, Baltic, and Dakota No. 12 had the best survival among the lots of American grown seed. Cossack had fairly good survival and one lot from Chile, one from South Africa, and one from India, showed ability to survive with good stands under the conditions. Two lots of Grimm had 99 and 98 percent survival respectively, and one lot of Chile had 98 percent survival, those being the highest in the trials. Survival of others not mentioned above ran from zero up to 88 percent with many of them maintaining less than half a stand. This corroborates previous field trials showing the adaptability of Grimm alfalfa to the conditions in the Willamette Valley.

SOY-BEANS

Soy-bean work has been continued at the Agricultural Experiment Station for many years. In 1926 a new trial was started including new introductions from North Asia and some selections made by the United States Department of Agriculture. In connection with the new trial a

permanent experiment is launched to determine the feasibility of certain varieties of soy-beans for summer hay. Annually inquiries reach the Station for information on a plant for cow or sheep hay after it is too late for vetches or field peas. While our soy-bean seed production has not been successful year after year in the Willamette Valley, because of late maturity, there seems a possibility for producing the hay. If standard varieties may be determined for this purpose, arrangements may be made in some of the warmer sections of the state for the production of the seed of those varieties.

Soy-beans may be planted from May 1 to 20. Experience indicates that inoculation is necessary. They make rather a good growth, and it is anticipated that good yields will be obtained from some of the varieties that are now being developed.

GRASSES

Grasses continue to receive attention. Many inquiries reach the Agricultural Experiment Station as to the best kind to use for pasture. More interest is developing in Western Oregon in the grass seed business that at any time in the recent history of the Station.

Seed market news. Through the cooperation of the Bureau of Agricultural Economics, a market news service is being carried out in connection with some of the grass and legume seed.

Farmers are growing large quantities of rye-grass. Some Tall Oat-grass, Orchard-grass, Harding grass, and bent-grass are being produced commercially.

The rye-grass that is principally produced is either a variety of Italian rye grass, or is a native that seems to have something of the characteristics of both English and Italian rye-grass. It survives well under winter conditions, produces a splendid quality of forage, is an abundant seeder, and offers promise for sowing in the logged-off land of the Pacific Northwest. On some of the low lands such as white lands, rye-grass together with Alsike clover makes a splendid hay crop.

Rye-grass grows well on black, sticky land, as well as on other of the heavy soil types where there is plenty of moisture. Seed of this variety has been marketed locally for pasture and quite extensively in the Southeastern States as a winter lawn grass where the Bermuda grass serves during the summer.

Timothy continues to grow well on the Agricultural Experiment Station. Some of the better strains are being multiplied in a limited way. There is little commercial production of timothy in Oregon, either for hay or for seed, except in a few of the high altitude sections in moist soils. Timothy is included in practically all pasture mixtures because of its cheap seed and its value as a producer of forage.

Tall oat-grass is increasing in sections of Western Oregon because of productivity under dry conditions and because it reseeds and spreads to a considerable extent. It is perennial and tends to occupy the land through reseeding.

While not as palatable as some other grasses, it is recommended for all upland pasture mixtures in Western Oregon and especially the dry hill areas of Southern Oregon.

Orchard-grass shows up well in the plots, and is one of the standard pasture grasses. More work in seed production of orchard-grass is needed.

Harding grass has been the subject of much controversy in recent years. It is a rank growing grass of the bunch habit. It is well thought of in moist regions of California. It has been tried out rather extensively in the Willamette Valley with little success as a pasture grass. There may be a future for it in the Coast District, but the shattering habit, in so far as its seed is concerned, and the consequent high price for it have precluded its general use in connection with pasture.

Reed canary-grass. This grass, which has become native in some of the Coast districts, is being extended in acreage. On moist land it is producing remarkable yields of pasture. It is recommended for the bottom and swampy lands in the Coast District, the Willamette Valley, and some of the irrigated areas. It has survived a number of Columbia River overflows, and is also recommended for that section, especially where there is some movement of water.

Seed has been reduced in price, and because of its permanent nature, its remarkable yield, and its palatability it is strongly recommended for swampy and seepy land pasture. In connection with creeping bent-grass as a bottom grass and possibly Ladino clover it will probably be the most productive of the pasture grasses for rather moist land.

Kentucky blue-grass continues to survive and maintain itself pretty generally against encroachment of other grasses. It is one of the best of the pasture grasses, and is recommended for all reasonably well drained upland mixtures.

Creeping bent-grass is being harvested as a seed crop in Coos county, and another bent-grass is being harvested in Clatsop county. Both of these are excellent turf grasses and predominate in their respective sections on low land.

While the Clatsop county bent-grass has not yet proved itself, it looks like one of the best of the turf grasses. The Seaside bent-grass from Coos county is proving very satisfactory for lawns and golf purposes. Annual tonnage varies from four or five tons to probably sixteen to twenty tons per year.

Meadow fox-tail has proved to be a discovery among pasture grasses for rather heavy land. It produces a good stand, maintains itself against encroachment, actually does away with some of the persistent grasses, and is exceedingly palatable. It begins to grow early and is suited not only to wet, heavy lands of the Willamette Valley, but also to the low land of the Coast.

Plans are under way for making a one- to two-acre planting to work out seed data and to foster seed production so that the price will be within the reach of farmers. Seed prices in 1925 and 1926 are generally about fifty cents per pound, which is rather high.

MISCELLANEOUS FORAGE

Rape. Experiments with rape seed production are continued.

Kale. The Thousand-headed kale is such an important plant in the dairy and poultry business of Western Oregon that some work has again been started with that crop to reestablish a desirable type for forage.

Sunflowers. Sunflowers are planted at short intervals from about mid-April until rather late in May or early June. The results are generally favorable to late April or very early May plantings. A planting time of ten days to two weeks ahead of corn planting time seems to be the most practicable time. Sunflowers offer opportunity for good silage yields where corn does not make good yields and when vetch may be scarce.

ROOT TRIALS

The trials with roots have been extended to include some of the Coast counties. This is in cooperation with the Branch Station at Astoria. A number of plantings of the leading varieties of mangels, turnips, rutabagas, and carrots have been made and this is to be continued for two more years.

The root trial at Corvallis is now confined to mangels and carrots as turnips and rutabagas do not seem to be generally suited to the Willamette Valley conditions. The Red Eckendorff, Danish Sludstrup, Half Sugar, Mammoth Long, Red and Yellow Globe, have all proved to be high yielders, with Half Sugar and Red Eckendorff substantially in the lead.

Mangel seed experiments were made in 1925 and 1926.

Sugar beets and mangels were grown in 1925, and they were left out over winter and lived through and produced seed in 1926.

Tests were made of the sugar content in 1924 and 1925 before and after rain, and these tests indicated that the sugar content remained good even after the fall rains had set in.

CEREAL INVESTIGATIONS

The cereal investigations for the harvest of 1924 followed along substantially the same lines as heretofore, with the exception that Major, a new Australian introduction, was the highest yielding variety. Its habits of growth are such that its recommendation is doubtful. Jenkin Club, Little Club, White Winter, Onas, Queen Wilhelmina, and Rink followed in order of yield per acre, although Queen Wilhelmina, Onas, Little Club, Jenkin Club and Major exceeded White Winter when compared to the nearest check. The winter of 1924-25 was an exceedingly cold one and resulted in a great deal of winter killing. The cereal trial was on rather poor land, and the results show Oregon No. 160 to be the best yielder, followed by Union No. 32-E, Oregon 157, Queen Wilhelmina, Oregon 155, and Oregon 70, when related to the nearest check. The average of all check plots of White Winter was 21.3 bushels, and of Queen Wilhelmina, 21.5 bushels. These two varieties are substantially the same in

yield. Jenkin Club, though seriously winter killed, came out and made 97.88 percent of the yield of White Winter, and Rink fell to 77.53 percent of the White Winter or standard variety. Major, Federation, Foise, Little Club, Rink, Blue Chaff and a number of the selections were very seriously injured by the cold weather. The results generally indicate that White Winter, Queen Wilhelmina, Jenkin Club, and some of the new selections are the leading varieties for Western Oregon.

Spring Wheat

The spring wheat yields of the harvest of 1924 were in the following order: Red Chaff, Jenkin, Red Fife, Huston, with Blue Chaff, Defiance, and Major tying for fifth place. There is little difference between Marquis, Huston, Major, Defiance, and Blue Chaff. In 1925 Huston was the highest yielder and was followed by Red Fife, Defiance, Marquis, Blue Chaff, Jenkin, and Red Chaff, the Huston being substantially in the lead.

It appears that for spring planting the Huston is generally the best, especially when the soil is moderately heavy, but that Defiance, Jenkin, Red Chaff, and Blue Chaff are all white varieties that offer some promise.

Oats

Gray Winter oats continues to be the best variety of winter oats. Of the spring varieties, Three Grain, Senator, and Victory were high in both years. Three Grain and Victory are recommended because of yield and quality.

Winter Barley

O. A. C. No. 7 is the best of the winter barleys.

Spring Barley

In 1924, Hannchen, Trebi, and Flynn were the leading varieties in the order named. In 1925, after the freeze-out of O. A. C. No. 7 in the fall, some of it was planted in the spring variety trials, and it proved to be the highest yielder, followed closely by Peruvian and Hannchen.

It appears that the Trebi is not so good a variety as Hannchen or O. A. C. No. 7.

Three beardless varieties, Colcess, Meloy, and Success, gave medium to rather low yields although the Colcess was a little better than Trebi.

Cereal Nursery

A number of exceptional selections from Red Chaff Club and from Jenkin Club, as well as from field selections, have been developed. A number of these are among the high yielders in the 1925 variety trials.

Work is being done extensively with some winter varieties of oats and winter varieties of barley in an attempt to get the same high yielding qualities of O. A. C. No. 7, and to get with it a little stiffer straw and greater winter hardiness.

A few selections of Gray Winter oats survived the cold winter of 1924-25, and these are being multiplied in the cereal nursery.

The general work is being continued in connection with the wheat and the beardless rye selections. Cooperation with the Moro Branch Experiment Station, relative to smut resistance in wheat, is also being carried out.

The Tillage Experiment

Depth of plowing. The depth of plowing experiments in both 1924 and 1925 showed lowest yields for the five-inch plowing. In 1924 the eleven-inch plowing was the highest and in 1925 the eight-inch plowing gave the best return *when fall plowed.* The eleven-inch plowing gave the best yields for spring, with yield declining for shallower depth.

Plowing before or after rain. In 1924 conditions were favorable for plowing after rain; and in 1925 for dry plowing before rain. Early spring plowing was substantially better than late spring plowing both years. There is little consistent difference in disking or not disking before plowing.

Rate and Date Trials

In 1924 the best yields were obtained with the November 7 sowing, with slightly lower yields for October 19, and substantially lower for October 9. For the 1925 harvest September sowing gave the best yields, with October 16 sowing substantially the same. Spring sowing on the fall plowed land in lieu of the late fall sowing gave substantially lower yields. Eight pecks of winter wheat at all times of sowing gave the maximum yield.

Spring Wheat Rate and Date

For 1924, the six-and eight-peck sowings of spring wheat were best. There was little significant difference between March, April, and early May sowing, although the May sowing gave the highest yield. In 1925, the late March sowing was substantially better than any other. The eight-peck rate was substantially better than the smaller rate.

Seed Flax

On the west farm, yields varied from 3.2 to 5.09 bushels per acre for Damont. These were planted rather late. Damont was the leading variety in earlier trials. Winona on the east farm, planted May 5, yielded 15 bushels per acre. The same variety planted under similar conditions June 1 yielded only 11.34 bushels. Of the varieties planted June 1, Reserve was the leader with 12.46 bushels. This trial again demonstrates the importance of early planting as well as substantial variation in yield of different varieties.

A rate-and-date trial with flax was made on the West Farm. Poor stands were obtained with the April 14 planting since it was followed by a rain that crusted the field, and no stand was obtained. The yield declined regularly from the April 25 planting to May 8, May 16, and May 29. The April 25 planting of thirty-six pounds per acre gave practically ten bushels, while the May 29 planting was not big enough to harvest. The thirty-six pound sowing gave the best yield for the April 25 planting, and was followed closely by the forty-four pound. For the later plantings, the forty-four pound sowing was substantially better than the thirty-six pound sowing.

Fiber Flax

In the fiber flax trial there was no substantial difference in yield between the Blue Blossom Dutch and the "State" seed, although the Blue Blossom Dutch slightly exceeded the State in weight of flax and in length. In a method-of-sowing trial in which seed was drilled with a double disk grain drill, a single disk clover or grass seeder, and broadcast with the grain drill, but not using the furrow openers, the yield with the two seeders drilling the seed into the ground was approximately 3,250 pounds of flax straw, as compared with approximately 2,550 pounds for that broadcast and harrowed in.

The broadcast flax had about 420 pounds more weeds per acre. In another trial, drilling on a firm seed-bed was substantially better than broadcasting on a firm seed-bed or on a loose seed-bed, either by hand or with a drill. Flax drilled at 44 and 73 pounds per acre respectively gave a better yield of straw and less weeds than broadcasting by hand at 112 pounds.

In 1926 a cooperative agreement was made with Mr. L. H. Dewey, of the Bureau of Plant Industry, for fiber flax investigational work. An experiment was started on the gravelly loam soil near Aumsville. An irrigation demonstration experiment was started in Linn county on leased land.

Seed Treatment with Flax

In an attempt to get at the effect of treatment on the yields, formalin and copper carbonate were used in comparison with non-treated seed. Formalin had a distinct retarding influence on the crop and made a yield of 682 pounds of straw as compared with 1,122 pounds for copper carbonate and 1,082 pounds for the untreated.

There was no evidence of any seed-borne disease in the experiment.

It appears that the fundamental things in connection with fiber flax, as well as seed flax, are (1) early planting on a firm seed-bed, (2) that drilling shallow gives much more prompt germination and uniform stands and yields with a smaller expenditure for seed.

Corn Experiments

The corn variety trial was reestablished in 1924. The highest yielding variety was McKay's Yellow Dent, producing 8.2 tons per acre. Nachter Brothers Yellow Dent produced the same yield, but did not mature. The Henry Ranch cold-resistant Golden Glow and O. A. C. Minnesota 13 both matured and produced 6 tons and 5.9 tons of silage, respectively. The McKay's Yellow Dent, Hughes Minnesota 13, and Northwestern Dent, Brown County Yellow Dent, and O. A. C. Minnesota 13 both matured and produced 6 tons and 5.9 tons of first and O. A. C. Minnesota 13 second among the mature varieties carrying full sized ears. In 1925, the McKay Yellow Dent and the Nachter Yellow Dent were highest yielders, producing 7.4 and 7.1 tons of silage respectively. Neither matured. Among the varieties that reached a satisfactory stage of maturity, the O. A. C. Minnesota 13, which was used as check, produced 5.86 tons an acre. It was exceeded in yield by

White Flint, Golden Glow, White Dent, Ross Early Dent, and two unnamed Yellow Dents, by yields varying up to 0.53 tons an acre.

In a small experiment to determine the effect of the place of application of fertilizing material upon stands, various fertilizers were applied underneath, in, and on top of the hills of corn at planting time. The more soluble fertilizers applied underneath and in the hills killed a good many of the kernels so that germination did not take place. Application on top of the hill made no injury. Calcium sulfate applied underneath, in the hill, and on top appeared to stimulate the corn to a considerable extent, and it made a greener and more vigorous growth.

POTATOES

The potato trials have been continued. Summarization of the results has not been completed, but the results are striking along a number of lines.

Certified seed, which is quite free from disease, makes outstanding increases in yield. Not all certified seed coming in from other states is even reasonably free from disease.

Generally speaking, factors which tend to produce a larger number of plants per acre tend to increase the yield. Largest yields were obtained from planting whole seed, or from planting large pieces with the pieces cut to produce a maximum number of plants per hill, or from the use of considerable quantities of seed in relatively small pieces, resulting in a large number of plants per acre.

The whole blossom end method of cutting continues to give favorable results. Whole seed, reasonably free from disease, produces a yield comparable with cut seed pieces weighing one-half to one ounce more. Pieces 1½ to 2 ounces in size are generally good for ordinary land. Early planting generally gives better yields than later planting. Five-inch depth of planting is generally a better producer than either three- or seven-inch depth. A comparison of two-man and one-man planters was begun. On rich land planting close in the row at 10 inches to 12 inches is better than wide spacing.

Fertilizers carrying nitrogen are usually more productive than non-nitrogen-carrying fertilizers. The application of soluble commercial fertilizers, even under circumstances where only a small part of the fertilizer comes in contact with the seed piece, results in very poor germination and substantial losses.

Seedling potatoes of the McCormick variety are being developed.

Sweet potatoes showed favorable results for the Yellow Strassburg and some promise for Triumph. Most of the sweet potatoes of the 1925 trial were stolen.

A good storage place for the potatoes was built in 1925.

WEED CONTROL EXPERIMENTS

During the biennium with the assistance of graduate and special students a number of weed control trials were made and some investigation of methods was undertaken. Sprays of sodium arsenite were

used in various strengths. A commercial weed killer, 38 percent arsenious trioxide, diluted to one hundred of water, proved effective on St. John's Wort, also known as Goat weed, but did not prove effective on Canada thistle. Sprays of various strengths made in Umatilla county in cooperation with County Agent Bennion failed to control wild morning-glories. An attempt to approximate the so-called fog conditions of the California coast district by spraying the morning-glories, then covering them with wet chaff and then with dry straw, resulted in complete failure, as but little injury was done to the leaves. In another experiment better killing was obtained where the morning-glories were out in the sun than where they were protected by the shade of an orchard tree.

It became apparent that where morning-glory plants presented the maximum amount of foliage, killing was deeper than where a minimum amount of foliage was exposed. This would indicate that possibly successive sprays might be more effective. It appears that where excessively strong sprays are put on at one time the killing is so sudden that there is little penetration.

Sprays of pyrolignious acid and of cedar oil distilled from white cedar sawdust proved ineffective against dandelions and Canada thistles, respectively.

A spray consisting of 20 percent solutions of ammonium sulfate, iron sulfate, sodium nitrate, and potassium sulfate was tried on different plots to kill mosses and dandelions and other lawn weeds. Ammonium sulfate appeared to be the most effective spray. Two sprays will very generally control heavy infestation of moss in a lawn, and will also take care of plaintain and other soft, wide-leaved plants. This spray does not control dandelion. The spray at the rate of 22 ounces to a gallon of water serves to dispose of many weeds and the moss and does not injure the grass except where the grass is much bruised, as by heavy tramping. The spray also fertilizes the grass. A small plot treated on the college campus lawn showed effective results through two seasons and then became reinfested with moss.

Another experiment was tried out in the control of dandelion. The sodium arsenite solution obtained from the United States Smelting and Refining Company containing 38 percent of arsenious trioxide was sprayed upon plots badly infested with dandelions and plantains. The strengths used were one-to-ten, one-to-twenty-five, and one-to-fifty of water. Enough material was sprayed on entirely to wet the surface of the plot. At one-to-ten all dandelions and plantains were killed, as was also a good deal of the grass. At one-to-twenty-five the dandelions and plantains were killed, although the perennial grass appeared to survive, while short lived annuals of the grass family were killed. The one-to-fifty spray killed the fuzzy leaved or False dandelion, but apparently did no injury to the common dandelion. Neither did it injure perennial grass. The one-to-ten plot was sprinkled to wash out the excess poison, was then raked and sowed to Seaside bent-grass seed, furnished by Mr. Lyman Carrier, of Coquille, Oregon. The weeds were killed and there is now a very good stand of bent-grass on the plot, even though conditions were not ideal for getting a stand of grass.

It appears that spraying of weed infested lawns with sodium arsenite in proper strength is the cheapest method of disposing of those pests, and very much more satisfactory than cutting them out, pulling them out, or jabbing into the heart of each one with a poisoned stick or other means of putting on poison.

MISCELLANEOUS SERVICE

Considerable work has been done in furthering the marketing of the Oregon seed crop. This has to do with various factors entering into the grades of farm crops, conditions for entering them into trade channels, and other factors affecting the sale of seed.

A market news service has been established, and this material has been given out over the radio and to the press since the establishment of the radio station.

Many talks have been given over the radio and much newspaper publicity has been given to the experimental work in connection with the various farm crops.

For the most part, judging at fairs has been eliminated as rather an unprofitable type of service.

A great deal of Extension work, consisting of conferences with county agents and other extension workers, participation in Economic Conferences, certification, and project work, has been carried out by members of the department.

Economic surveys of the Baker and Umatilla projects were made in cooperation with the Reclamation Service.

The seed laboratory made 3,961 tests on 2,951 samples of seed received during the two years. The seed analyst is making a careful study of the identification of seeds of the genus Brassica.

The seed laboratory is extensively used by farmers and dealers. Reports of the seed testing laboratory are used as a basis of settlement on a great deal of contract seed. The work of the seed laboratory has been particularly difficult during the past year because of numerous samples of bent-grasses and questions that have arisen over their authenticity.

Extensive exhibits were put on at the State Fair and at the International Livestock Show at Portland.

Three thousand seven hundred and sixty letters were answered through the Clerical Exchange during the biennium. The letters written by the secretary of the department are estimated at 1,144 per year, or a total correspondence of 6,004 for the biennium.

Many of the inquiries reaching the department call for rather extensive study of statistical material and sometimes take a great deal of time in the preparation of an answer.

DEPARTMENT OF SOILS

SOIL FERTILITY INVESTIGATIONS

Fertility rotation. Thirty-two rotations started on 92 plots in 1915 are being maintained and are giving more and more striking differences. Where manure, clover, or lime has been followed with grain the yield of winter barley after 10 years is 75 bushels per acre, while the yields on plots continuously cropped to grain is about 26 bushels an acre; grain after clover and potatoes, 58.75 bushels; grain after vetch and potatoes, 72.5 bushels; grain after clover—clover—corn, 75 bushels.

In the irrigation field are the oldest plots in the state that show the cumulative effect of constructive soil treatment. They cover a period of four 4-year rotations. In this field four 3-year rotations have also been carried out and have just about doubled the yield of beans following clover and grain in rotation, as compared to beans being grown continuously. The increase from crop rotation is almost clear profit. It is an important means of increasing profits when cost of production runs high and prices for farm crops are not high. The value of rotation and fertility experiments increases with the duration of an experiment. These trials should be maintained indefinitely.

Fertilizer experiments. Fairly complete fertilizer trials are being continued on a score of different soil types in the state. A new systematic experiment has been established for Willamette silty clay loam on the Home Station, with three series of plots containing 25 plots each, one series being cropped to grain, another to clover, and a third to corn each year. Additional cooperative fertilizer experiments are needed on a few other important soil types in the Valley and should be started promptly. It is estimated that at least $500,000 is now expended in Oregon annually for fertilizers and that $\frac{1}{3}$ of this amount is wasted by improper use. On some of the older trials none of the treatments employed proved profitable.

Successful use of fertilizers depends on their cost and value of crop increase obtained from them. Certain fertilizers for given soils have proved very profitable and their use as a farm practice is recommended. More studies are needed to determine the economical amount of effective fertilizer to use and the time and frequency of application.

Phosphorus. The availability and utilization of phosphorus in soils of high iron content is one of the fundamental soil problems of Oregon. Results to date are being reported in bulletin form. These studies made by Professor Ruzek are described by him as follows:

"The phosphorus problem on the red-hill soils has dealt with the effect of soil reaction on the availability of the phosphorus in these soils. The results indicate that the amount of phosphorus in the soil solution for crop use at any one time at these different reactions is very small. Varying amounts of elemental sulfur and of precipitated calcium carbonate were applied to obtain different pH reactions. The sulfur applications ranged from 200 to 2,000 pounds per acre, and the calcium carbonate from 500 to 8,000 pounds per acre. The treatments after a period of

nine months gave a range of reaction of pH 5.1 to pH 7.2. The phosphorus content of the soil at these different reactions, using a two-to-one water extraction, showed no marked differences but in each case a mere trace of phosphorus was found.

"Additional series of this soil were treated with mono-basic calcium phosphate for their absorptive capacity. The results show that for the entire range of reactions the absorptive capacity is high and takes place very rapidly. The largest amount added was 20 parts per million of PO_4 to soil, all of which was absorbed by the soil. This would indicate that where soluble phosphate fertilizers are added to these soils it is immediately precipitated, but is more available for crop use in this state for some time, as shown by field and greenhouse trials."

Sulfur. The study of the fineness of grinding lump sulfur in order to make it available at a rate to meet plant requirements has been concluded, and it is found that for typical Oregon soils sulfur ground so it will all pass a 20-mesh sieve is adequately fine.

The ultimate effect of sulfur applications to soils has been a matter of much concern and its effect upon the solubility of soil constituents and composition of the soil solution has been studied. Ordinary field applications are found to improve the reaction of arid soils for alfalfa, to liberate calcium and other bases, and on certain soils to provide a more favorable concentration of sulfate. Sulfur increases the protein content and chlorophyl content of alfalfa, and evidence has been obtained that it plays the role of a catalyzer or accelerator of chemical activities connected with the synthesis of these constituents.

Sulfur has proved effective at the Vale experiment field in flocculating heavy alkali land and improving the reaction for plant growth. A little calcium sulfate appears to aid action of nitrogen-fixing bacteria, and to aid in establishing a stand of certain legume crops. A little sulfur on arid soils appears to be beneficial to nitrifying bacteria, while larger amounts inhibit nitrification. Since the continued use of sulfur tends to develop acidity, sulfur may be expected to be more safely used as calcium sulfate on acid soils of Western Oregon. The ordinary application, which is 75 to 100 pounds an acre each three or four years, is certainly profitable, and is probably a safe practice where the crop grown is fed out on the land.

Potash. Residual soils in the Deschutes Basin continue to give profitable response from potash application to potatoes, and potash fertilizer is helpful and frequently profitable on other crops that return a good value per acre and are heavy users of this element in that section. Potassium sulfate is a preferable form for that section due to the value of the sulfate residue for legumes. This form is also less likely to aggravate alkali trouble. Potash fertilizers continue to increase onion yields on some deep peat soils, as on Lake Labish. But other factors are to be considered in fertilizing for crops on this soil and more work needs to be done.

Nitrogen. Nitrate fertilizers have proved helpful where legume sod could not be obtained for growing cash crops. The use of legumes is regarded as a more constructive and profitable treatment than the appli-

cation of commercial nitrates, except as a starter, where rainfall or irrigation makes it possible to obtain this element from the inexhaustible supply in the air by means of nitrifying bacteria and legumes. In Western Oregon the cool, damp weather inhibits nitrate formation and facilitates leaching out of any available nitrates. A light application of nitrates early in the spring has proved beneficial on chlorotic grain fields and on cover crops on certain orchards. Sodium nitrate can be more safely used on soils tending to be acid, while ammonium sulfate is proving more effective on neutral or alkaline soils of heavy texture where continued use of sodium salts tends to puddle the soil. Indirect fertilizers have proved useful for increasing the growth of shade crops and cover crops on run-down orchard soils. These applications may be discontinued after fertility is restored so that a good growth of legumes is readily obtained.

Soil acidity and liming. Certain phases of this project have been described by Doctor Stephenson as follows:

"The acidity survey of Willamette Valley has been continued and may soon be completed.

"In addition, special soils have been taken up for acidity studies. The Waldo silt loam from Shaw, Oregon, has been found to have a very high lime requirement. This soil also gives wonderful field response to applications of limestone. Another soil, Veneta silty clay loam from the Eugene area, one of the newer series, is also in the process of study.

"In addition to the usual procedure, these soils are being studied from the standpoint of base saturation and hydrogen ion concentration.

"During the past year also a reaction profile study has been started on some of the Willamette Valley soils. The different horizons are studied for lime requirement, hydrogen ion concentration, and base saturation.

"A study of replaceable bases in certain Oregon soils has shown that certain very acid soils of Western Oregon have been largely exhausted as to replaceable bases."

The effect of hydrogen ion concentration on certain plants and bacteria has been studied. Certain typical plants, including legumes, are found to grow best in a very slightly acid medium. Even when legumes are caused to secure their nitrates through association of bacteria, the maximum growth results in a very slight acid reaction. More nodules were developed in neutrality. Hungarian vetch was found to tolerate a slightly higher acidity than alfalfa. This likewise applies to Alsike clover, which is found to grow best at a pH reaction of 5.5 to 6.0. Mint grows best at a pH value of 6.0. Rhododendron appears to grow best at a pH of 5, and seems to require this acid condition rather than the presence of aluminum, even two parts per million, this proving toxic. Hydrogen ion concentration of field soils where these crops were flourishing was determined in several cases for the plants studied, and they were found to flourish in a slightly to definitely acid medium. Roots in contact with the soil solution may cause the reaction to change to a slight acidity, due to the production of carbon dioxide and the formation of carbonic acid. Alfalfa plants tend to bring the reaction to about pH

value of 6. The optimal reaction for these plants grown in the field appears to correspond to the best reaction range when grown in controlled culture solutions. Full advantage should be taken of soil reaction range in which resistant crops grow well. It seems then unnecessary to correct the total acidity. Lime may be expected to benefit soils that are distinctly acid or are of medium fertility and heavy texture, particularly where such legumes as alfalfa or clover are to be grown. Lime continues to pay in experiments on Willamette silty clay loam, and gives more definite increases on the so-called white land or Dayton silty clay loam.

Organic manure. A project has been continued to determine the supply and the best method of increasing and maintaining the organic matter in Oregon soils. The reduction of grain straw to manure by the use of lime, ammonium sulfate, a little phosphate and water, is a promising process.

Studies in the use, care, and value of manure have been continued. Manure and lime in 1925 gave a yield of 72⅝ bushels of wheat an acre as against 60 bushels for untreated plots. Crop residues have been employed and good increases have been obtained from the application of grain straw in connection with irrigation. A depressing effect has been noted the first season following turning under of oats and vetch as grain manure and nitrate; determinations show that this is due to withdrawal of available nitrates by the decomposition organisms which temporarily deprive the growing crop of these nutrients.

An experiment has been concluded during the biennium which has determined losses of stable manure exposed to Western Oregon weather. This study is summarized by Professor Ruzek as follows:

"Where straw or other absorbents were used, the total loss of plant food was increased, but the percentage loss was decreased. Superphosphate was found to be most effective as an absorbent for preventing loss by leaching."

SOIL SURVEY

In cooperation with the U. S. Bureau of Soils field work for the detailed soil surveys of Linn and Lane counties has been completed and the report prepared. During the past season one party has worked in Lane county, and some four months' work remains to complete the mapping of that county.

Published soil reports have been received from the Josephine county soil survey and the Benton county soil survey. Reports have been prepared and are in press covering Clackamas and Polk counties. With the completion of Marion county, there will have been a detail survey covering 5,939,323 acres, including all Willamette Valley counties outside the National forests. Josephine county was mapped in detail in 1919, making a total of 6,568,233 acres mapped in detail in Western Oregon.

A soil survey of Grande Ronde Valley, Union county, should be completed by September 1, and will cover approximately 200,000 acres.

Official samples of each type in each county have been collected and submitted to the station chemist for analyses. These analyses have been completed except for Lane and Marion counties.

These surveys are recorded on a map with a scale of 1 inch to the mile, the soil types being represented in different colors. All important landmarks have been shown on the base map used. From these maps a farmer can tell what type or types of soil cover his farm. From the analyses he can learn their average composition, and the field fertilizer experiments which follow on the main soil type give information as to the fundamentals for development of permanently profitable systems of soil management for these lands.

The surveys serve as an invoice of agricultural resources and as a basis for soil investigations. When funds are provided, a comparative report on the reclamation, improvement, and maintenance of Willamette Valley soils can be prepared.

Feasibility surveys. Preliminary feasibility soil and agricultural surveys have been made during the biennium of six irrigation projects, including 301,300 acres, and of two drainage projects, including 2,500 acres.

A total of nearly 3½ million acres has been thus examined during the past few years, and 1¼ million of this has been organized for reclamation.

Three of these projects were examined, in cooperation with United States Department of Agriculture representatives, for the U. S. Reclamation Service the past biennium; namely, Vale, Owyhee, and the north unit of the Deschutes Project. The investment involved in the four is nearly $32,000,000. These feasibility surveys establish the merits of reclamation for a feasible project, and help to cull out less desirable lands and shape them up in the most desirable way from an agricultural and economic standpoint. A detailed soil, agricultural, and economic survey of Ochoco Irrigation District is being started for the State Securities Commission.

Assistance has been given in designing tile systems and individual pumping plants and irrigation systems, as Extension work, but based on Station results.

DRAINAGE AND IMPROVEMENT OF WET LAND

Water-table, outflow, and yield data have established a suitable drainage coefficient for main drains for "white land." The effect of clover, lime, and manure in aiding drainage in the field and in lysimeter tanks has been continued. Drainage and crop rotation with legumes made possible the production of a crop of 65 bushels of winter barley per acre on the drainage experiment field in 1924.

The drainage experiment located on the leased ten-acre tract of alkali land near Vale, in Malheur county, has been continued. One season of drainage and copious irrigation is found to remove the larger part of the white alkali; four seasons of leaching have failed to remove any appreciable amount of the black alkali without chemical treatment. The present season four plots without chemical treatment are as bare as tennis courts, although seeded and cultivated like the adjoining plots, which

have received chemical treatment and which are producing good crops of rye, sweet clover, and alfalfa. The use of sulfur or land plaster in conjunction with farm manure has neutralized and flocculated this heavy alkaline soil and converted the black alkali to more soluble form so that its removal has been partly accomplished from the surface layers of soil, as shown by careful chemical analyses of composted samples of soil taken from the different horizons of all plots and analyzed annually. Seeding a grass mixture on native brush land and applying copious irrigation has brought in a growth of tame grasses of good carrying capacity on a portion of this land, and has effected partial reclamation, as judged by chemical determinations.

Lysimeter studies conducted to determine the composition of drainage water obtained from soil bins containing typical Oregon soils have been maintained and are reviewed elsewhere in this report.

DUTY-OF-WATER INVESTIGATIONS

Duty-of-water investigations have been conducted on the experiment fields at Corvallis, Grants Pass, Medford, and in cooperation with the branch experiment stations at Union, Hermiston, and Burns. Due to lack of funds such studies were dropped in Deschutes Valley.

In the Willamette Valley, supplemental irrigation in connection with intensive trucking and dairying is becoming more timely. Irrigation has saved the stand of red clover and has made late season pasture possible. At the Home Station, where experiments have been maintained for sixteen years, the average increase in yield of potatoes has been 90 bushels. Water has made 5 bushels more white beans, 5 tons more beets, 3 tons more corn fodder, and an average of more than 2 tons increase in the yield of alfalfa or clover hay. Approximately a 6-inch depth per acre is required for annual crops, and a 12-inch depth for perennial meadows on the heavy soils of the Valley floor. About 50 percent more water is required on the sandy bottom-land.

The crop-producing power of water has been determined in connection with these studies during the past sixteen years, based on an average of the results obtained each year for the plot of each crop which has given the maximum net profit per acre of the highest probable yield per unit of water under good modern methods of farming, which is found to be as follows:

Approximately 5 inches per acre of water is needed to make a ton of alfalfa; 4 inches per hundred bushels of potatoes; ½ inch per ton of beets. The record for the period indicates that these figures would not be substantially changed if the experiment were to be continued indefinitely.

In water variation trials in our irrigated valleys under good conditions, we have produced a ton of alfalfa with about 6 inches of water. Where twice this amount is used per ton produced, as is often the case, there is something wrong with the irrigation method. In the Rogue River Valley experiments on granitic soil, a 2-feet depth per application had been used on a certain farm, and it was found possible to apply a 5-inch irrigation, or about what the soil would retain, by doubling the

irrigating head and cutting in two the length of run. It will save time, water, and money to establish proper methods of irrigation, and this is the object of the Southern Oregon studies.

MISCELLANEOUS STUDIES

(1) Soil correction trials on "black sticky" and on "white land" have been continued. Lime and manure have increased the yield of rye-grass and Alsike clover on the black clay, and have increased the yield of Alsike on "white land."

(2) Tillage and soil moisture studies have been continued in connection with irrigation and drainage experiments. Crop rotation and the use of manure or of lime have increased the average moisture content during recent dry summers on soil experiment fields. These treatments have decreased the water requirement or irrigation requirement per unit dry crop. In the irrigation field, crop rotation and the application of manure once each rotation, together with supplemental irrigation, has cut the water requirement in two as a 12-year average.

(3) A special study has been made of means of improving the permeability of certain heavy soils with imperfect drainage. These studies have included laboratory and field trials with the soil material and laboratory studies with the colloids isolated from these soils. The flocculating power of these salt solutions is found to be related to their valence and atomic weight. The effectiveness of sulfur for improving puddled alkali land appears to come about as follows:

When sulfur oxidizes and combines with water to form sulfuric acid, this reacts on calcium and other basic compounds, and the increase in calcium in the soil solution causes the flocculation, which is a neutralization or precipitation of the oppositely charged colloidal particles.

(4) Titration studies with colloids from four heavy soils, including muck from Lower Klamath Marsh, failed to show an iso-electric point even for the organic colloids. The titration with acid appears to replace the mono and diabasic constituents, while the tri-valent cations remain in the colloid complex at high acidity.

(5) Percolation studies conducted on soil from the Vale experiment field and from "white land" subsoil show that a saturated solution of calcium sulfate is one of the most effective flocculating agents for increasing percolation.

MISCELLANEOUS SERVICE

Correspondence. There is an increasing correspondence due to lack of soil reports and information regarding the nature of soil on particular tracts, requests for information bearing on reclamation by irrigation or drainage, and the fertilization and management of crop land.

Office calls. Consultations for information in connection with proposed investment or development of land enterprises demand a large amount of time of the small staff in Soils.

Field calls for assistance in shaping reclamation projects or solving special soil problems which require investigation come unexpectedly as emergency work, and require much of the summer or unscheduled time of staff members qualified to do this work.

DEPARTMENT OF AGRICULTURAL CHEMISTRY

INVESTIGATIONS IN ANIMAL NUTRITION

In cooperation with the department of Dairy Husbandry, mineral balance studies with dairy cows have been continued through the late lactation period and gestation period. From our observations through the total reproductive cycle there apparently is no depletion of the mineral reserves on a ration of red clover hay, silage, and grain. The negative calcium and phosphorus balances noted during the early lactation period were changed to positive balances by the feeding of bone meal. Kale favorably influenced the milk yield and mineral balances. The results of this series of tests have been published in the American Journal of Physiology for June, 1924, May, 1925, and February 1926.

Preliminary to preparing synthetic rations satisfactory for growth, reproduction, and lactation with small animals where certain minerals may be quantitatively controlled, it has been observed that extracting corn with water and feeding the extract of corn causes failure in reproduction. In determining the nutritive requirements for successful growth, gestation, and lactation experimental evidence has been obtained to show that the percentage of vitamin B in a ration is no greater for gestation and lactation than for growth.

Additional evidence has been obtained to confirm our earlier statements pertaining to the ability of the animals to retain sodium and chlorine for physiological well-being during high potassium intake. A part of these data was published in the Journal of Biological Chemistry for January, 1926. More definite information relating to the potassium requirements for growth has been obtained, and will soon be submitted for publication. Sodium deficiency in corn has been demonstrated in the study of the small animals, and this report is now in press.

INSECTICIDES AND FUNGICIDES

Research work in this field has been continued under the project heading, "The Study of the Physical and Chemical Properties of Some New Insecticides and Fungicides."

Spreaders for spray materials. The theoretical work pertaining to spreaders for spray materials was completed some months ago. It was concluded that neither surface tension nor interfacial tension values indicate the spreading properties of spray solutions made up to include spreader substances. Low values here, however, indicate the probability of spreading properties. Of the many substances studied, it was noted that the water-soluble protein material gave best spreading on the greatest number of surfaces tested. Of all the proteins studied, skim milk, or other milk products, such as dry skim milk, condensed milk, clabbered

milk, and buttermilk, gave by far the best spreading effects. These materials have the additional advantage of being available in any amount desired and at reasonable prices.

The action of many spreader solutions was found to depend on several variable factors, such as the type and the age of the surface to be sprayed, the force used in spraying, and climatic conditions. Orchard and laboratory experiments show that an effective spreader in lead arsenate spray increases the amount of arsenate which penetrates the calyx cup when applied as a calyx spray. In this way it increases the effectiveness of control. A detailed report of this work is to be found in the Journal of Agricultural Research, Volume 31, July, 1925, under the title, "Spreaders for Spray Material and the Relation of Surface Tensions of Solutions to Spreading Their Properties."

Oil emulsions. Our most recent work in this field of investigation has to do with a study of oil emulsions, particularly the home-prepared ones.

Preliminary observations indicated that the emulsions of some mineral oils by the cold process method were of very poor quality, while emulsions of other oils of the same type were excellent in every way. Accordingly, much effort has been expended in determining the effect of various emulsifiers on the emulsions derived from different mineral oils, on their stability, the size of oil globules formed, and the quality of the emulsion immediately after preparation, and again after aging for one week.

In the case of protein emulsions, such as are formed when casein is used as the emulsifying agent, it has been noted that quality and stability are influenced very markedly by the presence of certain reaction products, which remain in the oil after chemical treatment in the purification processes. Some substances that in themselves are good emulsifiers can be made to improve the quality of emulsions prepared from oils that ordinarily produce poor emulsions. Low interfacial tension values between any oil and an emulsifying solution indicate to a certain extent the quality of emulsion that may be prepared from the oil and the emulsifier solution. It is necessary to emulsify at a high pressure, and proteins, such as casein, skim milk, hard wheat flour, when used as emulsifying agents must be brought into solution to obtain the best results.

Various mineral oils are also being studied from a chemical and physical standpoint in an effort to establish reasons for the greater effectiveness of some oil sprays over others. Nothing very positive on this phase of the investigation has yet been obtained. Laboratory prepared emulsions are now being used in orchard experiments to confirm if possible our laboratory data.

Bordeaux-oil sprays. An elaborate series of field tests of bordeaux-oil sprays has been carried out in cooperation with the Hood River Branch Experiment Station. The resulting data are being assembled for publication in the report of that Station.

In the course of research work on insecticides and fungicides a great deal of experience is gained in the compounding of spray mixtures.

Whatever appears to be of practical import is published from time to time in circular form as a guide to orchardists in the preparation of such mixtures. Station Circular 68, Sprays, Their Mixing and the Compatibility of Various Combinations, issued in February, 1926, is of this nature.

PRUNE STANDARDIZATION

In cooperation with the Fruit By-products division of the department of Horticulture, work is in progress from which is expected eventually a system of grading for dried prunes that will insure a far greater degree of uniformity in quality within the several grades than now prevails in the marketing of that crop. Since acids and sugars are probably the predominating compounds that impart such qualities as are distinguishable by taste to this fruit, a great many analyses have been made for these components on samples of the Italian variety, separated into grades.

SOIL SURVEY

Chemical analysis of soil samples taken by the field parties of the Bureau of Soils and our department of Soils as representative of surface and sub-surface zones within soil types has progressed satisfactorily. Linn county has been added to the list of completed counties in the Willamette Valley, and work on Lane county is well along toward completion. With the completion of work in Marion county next year, chemical data for the principal soil types in 12 counties of Western Oregon will have been obtained.

SOIL INVESTIGATIONS AT HOOD RIVER

Early in 1925 at the suggestion of the Hood River Branch Experiment Station, a series of determinations on orchard soils of the Valley variously treated in regard to practices of cover cropping was undertaken to find out what might be the influence of cover crops and various methods of disposing of them on the development of available soil nitrogen. From the data obtained it is apparent that a leguminous crop—vetch or alfalfa—disked or in some manner turned under, is the means of inducing the formation of large amounts of nitrogen in nitrate and ammonia form. In 1924 these forms of nitrogen dropped off early in November. In 1925 they persisted strongly into December. There are many factors involved here but a reasonable conclusion from this investigation would seem to be that these leguminous cover crops are the means of yielding to the trees and to crops the much needed nitrogen for thrifty appearance and growth.

ENFORCEMENT OF STATE CONTROL LAWS

Fertilizer and agricultural lime inspection. In carrying out the provisions of the Oregon Fertilizer and Agricultural Lime Law, 158 samples were officially inspected and analyzed. On complaint of several consumers it was necessary to adjust to the satisfaction of the buyers the

sale of some brands that did not come up to the guaranteed analysis. Station Circular 58, Commercial Fertilizers, reports the results of this work.

Economic poison inspection. Under the provisions of the Oregon Economic Poison Law, 188 different insecticides, fungicides, and weed killers were inspected and analyzed. While no flagrant violations of the law were apparent, it was necessary to request changing of labels in some cases, and to require certain manufacturers to lower their guaranteed percentage of active ingredients present in some of their products.

Station Circular 64, The Chemical Composition of Insecticides and Fungicides, reports the results of this work, and advises regarding the quality of various spray materials offered for sale in this state.

In connection with this work commercial stock insecticide dips have been given some special attention. Preliminary observations indicated considerable variation in the composition of commercial sheep dip. In order to learn more regarding the dip, chemical analyses were made of representative samples collected from different parts of the state. The data obtained enable us to recommend regarding the general use of the dips, the principal active ingredients they contain, and to advise regarding preparations that may be expected to give best results.

MISCELLANEOUS ACTIVITIES

A heavy correspondence follows as a natural result of the department's activities in the enforcement of the state's regulatory laws on the sale of fertilizers, lime, insecticides, and fungicides. Personal conferences, too, with large numbers of people interested in one way or another in these matters appear to be necessary. Growing interest in nutritional investigation brings into the department for conference increasing numbers of people interested in the application of that work.

Two members of the department have broadcast on timely topics in connection with the general broadcasting program of the College.

DEPARTMENT OF BACTERIOLOGY

A microbiological study of certain Willamette Valley soils having acid reaction. This continues to be the major project of the department. Previous studies have dealt with the relationship of lime to the microbiological activities of the soil of the Willamette, Amity, and Dayton series. The results of these investigations have been reported previously.

Subsequent studies have dealt largely with the relation of fertilization to the microbiological activities in the soil. These studies have been confined to the plots of the fertilizer range of the Oregon Agricultural Experiment Station and are located on "Willamette Silty Clay Loam." The plots are cropped each year in rotation. The rotation used is winter barley, clover, and a cultivated crop.

There is seldom more than a trace of nitrate present during the growing season of the barley or the clover. A small amount of nitrate

accumulates during the growth of the cultivated crop. Laboratory tests have been made to determine the relative nitrate-producing powers of the soils from the plots variously treated. These tests were made according to four different methods and incubated simultaneously. The methods include incubating the soil itself and determining the amount of nitrate formed from the organic matter of the soil, by the use of ammonium sulfate alone, by the addition of ammonium sulfate plus calcium carbonate, and by the use of blood meal. Investigations demonstrate the value of lime and manure stimulating nitrate formation.

The rapidity of recovery of the soils from the fertilizer plots after they have been exhausted of their nitrates through cropping is now being studied in the laboratory under controlled conditions with optimum moisture content maintained. Observations are being made on the nitrate content, bacterial content, and the hydrogen-ion concentration of the soils.

Cross-inoculation of legumes. Investigations are being carried on in regard to the production of artificial legume inoculation by the pure culture method. Tentative cross-inoculation studies have been made with the various cultures isolated. Results in this department do not always confirm the work of previous investigators in regard to the natural grouping of legumes for cross-inoculation purposes. It seems that purple vetch and horse beans (*Vicia faba*) each require a separate culture rather than the Common vetch and pea culture, respectively.

Production of bacterial cultures for artificial inoculation of legumes. This work is carried on mostly as a service to the farmers of the state, but observations as to the effects of artificial inoculation and methods of inoculation are being carried on. Cultures sufficient to inoculate approximately 7,000 acres are sent out to farmers each year. In cooperation with two different county agents and several private individuals, test plots are left to observe the value of artificial inoculation and different methods of inoculation are being tried out. Where the conditions are favorable, inoculation is proving to be exceedingly valuable and often makes all the difference between success and failure of the crop. It seems very evident that in the inoculated soils the crops are heavier, sturdier, of better color, and in the case of peas and beans the yield is much heavier and the product of exceptional quality. Commercial canners throughout the state are recognizing this and cooperating with the department in furnishing the artificial inoculation where necessary.

Hemorrhagic septicemia in sheep, cattle, and hogs. This disease does not seem very serious in cattle or hogs, but is getting increasingly severe in sheep. The department sends out about 10,000 doses each year. The majority of these are for sheep. Some use it as a preventive measure; others vaccinate when the disease is in the flock or herd. In previous years the results of the vaccination have been excellent. During the last few months we have received reports not so favorable. There is a serious question whether the diagnosis is correct in all cases, but there are undoubtedly some instances in which the vaccine has failed to give very favorable results. The department is carrying on field observations to as great an extent as possible, to determine the

source of the infection, the value of preventive measures, and the effect of the vaccine in diseased flocks and herds.

Bacterial analyses of milk. The department makes about 750 bacterial analyses of milk each year. The cost of these analyses is covered by the charges made. Work is done for the College, for the community, and for the neighboring cities. A large number of analyses have been made in cooperation with the State Dairy and Food Commission in improving the milk supply throughout the state. There is no bacteriologist attached to the Dairy and Food Commission office, so this department has furnished that assistance. The department is doing this as a service to the state, but also in the attempt to work out a practical, efficient means of testing the milk supply in the small cities, a thing which at present is wofully neglected. Because of the economic difficulties and lack of laboratory facilities the small towns are almost without protection in their milk supply. It is thought that a solution of the problem is in sight.

Bacterial analyses of water. The department makes between 600 and 700 analyses of water each year. This is strictly a service to the farmers, the small communities, and the small cities. The department is making these analyses free, is calling for certain data when the water supply shows pollution, and is following up the situation with suggestions and repeated tests until a pure source of water is furnished, if this is at all possible.

Clinical analyses. The department makes all the clinical analyses for the College, many of them for the community and the surrounding country. Laboratories of this type are exceedingly scarce in Oregon, hence the work is done largely as a humanitarian service to the people of the state. The cost of this is borne by the people taking advantage of the service.

Bacterial analyses of preserved foods. The department does the bacteriological work for the section of Horticultural Products in its food preservation work, the isolation of organisms in spoiled food products, and the bacteriological work in connection with the investigation of procedure, processing, and other phases of food preservation. The same service is extended to a limited extent to some of the commercial canners throughout the state.

DEPARTMENT OF FARM MANAGEMENT

FIELD OF WORK AND EARLIER PROJECTS COVERED

The field of work in Farm Management as organized at this Station covers three major subjects—Farm Organization, Cost of Production, and Land Economics.

Prior to July 1, 1925, the work in this field was not permanently nor adequately funded, only $500 to $600 per year being available for use for travel expense on such projects as were feasible through cooperation with the United States Department of Agriculture, the Extension Ser-

vice, and use of part of the time of members of the College instructional staff, to whom no station salaries were paid.

Under this arrangement, prior to July 1, 1924, three major projects were completed, one major project was put well under way, and two minor projects were carried forward. These projects were as follows:

Major Projects. 1. A three-year study of the cost of wheat production and the wheat farm organization in Eastern Oregon in cooperation with the United States Department of Agriculture and the Extension Service.

2. A five-year study of stump land reclamation.

3. A five-year study of farm building plans best adapted to Oregon conditions.

4. The first year's work on a three-year study of the cost of prune production, and the prune farm organization in Western Oregon.

Minor Projects. 1. Studies in farm reorganization planning.

2. Limited studies in farm organization by the survey method in many different counties over a period of ten years, in cooperation with the Extension Service.

WORK OF THE BIENNIUM, JULY 1, 1924, TO JUNE 30, 1926

During the first year of the biennium, funds were still lacking, hence the only major project carried forward was the work on the prune enterprise study, the second year's survey having been completed.

Beginning July 1, 1925, Purnell funds became available and the work in farm management was permanently funded on a scale adequate for substantial projects.

Following consultation with all of the commodity departments to determine their views, interest, and desire to cooperate, a complete program of needed work in the field of farm management was prepared, and from this were selected the projects most urgent and work begun. By June 30, 1926, the work laid out for the year was completed and reported in full. A brief summary of the work by projects follows:

Purnell Project No. 1—Prune enterprise study. This project is carried as a cooperative investigation by the departments of Farm Management and Horticulture. At the time this project was initiated (1924) the dried prune production of the United States (almost exclusively confined to the Pacific Coast) was 250,000,000 pounds. During the previous ten years the number of bearing trees had increased 30 percent, marketing was not well organized and the price, beginning with 1920, was not commensurate with the cost of production. During the same period the number of non-bearing prune trees had increased 200 percent and the outlook indicated a doubling of production within a very few years. One of the most desirable enterprises of Western Oregon and the Pacific Slope seemed to be facing a very difficult situation, with but two reme-

dies in sight, (1) improvement in the marketing of the commodity, and (2) reduction in the cost of production, the latter seeming the more certain of results.

As no data were available here or elsewhere on the cost of producing prunes, the purpose of this project was to determine the costs and the most efficient methods and farm organization for the reduction of cost.

During the year beginning July 1, 1925, the computation work on the 1924 crop survey was completed and the field survey work on the 1925 crop carried through.

This study covers complete cost records on 111 prune orchards in the Willamette and Umpqua Valleys, comprising 2,662 acres of bearing prunes producing 5,000,000 pounds dried, per year. The average acreage of bearing prunes per farm was 24 acres. The average capital investment in the bearing prune orchard was $14,500 per farm. The average capital investment in the entire farm on which the prune enterprises were found was $29,500 per farm.

Many of the factors responsible for wide variation in cost are already clearly indicated, and the completion of the three-year study will make the factors in reduction of cost that are within the control of the growers definitely known. The basic unit cost, the distribution of labor, and the man, horse, tractor, and machinery labor requirements per acre for every operation were all definitely determined.

Computation of the 1925 crop survey and summarizing and factor study of the completed three years of work will constitute the program in this project for the coming biennium.

Purnell Project No. 2—Pear enterprise study, Rogue River Valley. This project is carried as a cooperative investigation by the departments of Farm Management and Horticulture. The outstanding enterprise of the Rogue River Valley is pear production. The individual and general investment in this enterprise is very large, and the reputation of this product is country-wide. The need for determining cost and the most efficient methods of production and the economic status and trend of this enterprise has become apparent in recent years, and at the request of the organized growers the study was undertaken. No data were available on this enterprise, either here or elsewhere.

Both the field survey and the computation work on the 1924 crop and the field survey on the 1925 crop were completed during the year beginning July 1, 1925.

Complete cost records of 58 representative pear orchards were obtained, comprising 2,427 acres of bearing pears producing 268,000 boxes. The average acreage of bearing pears per farm was 42 acres. The average investment in the bearing orchard was $40,000 per farm.

Some of the major factors influencing costs are already clearly shown, and completion of the study will establish these factors and the most efficient practices. Basic unit costs and the labor requirements for every operation were obtained. An extensive study of the economic status and trend of the enterprise has been made by the department of Horticulture as a phase of the project.

Computation work on the survey of the 1925 crop and the survey of the 1926 crop will constitute next year's program.

Purnell Project No. 7—Forage enterprise study. This project is carried as a cooperative investigation by the departments of Farm Management, Farm Crops, Animal Husbandry, and Dairy Husbandry. The cost of production of livestock and livestock products and the most economical feeding rations are directly dependent on the cost of most efficient methods of producing the various kinds of forage, particularly hay, silage, roots, kale, pasture, and feed grains. Because of the interest of the livestock and farm crops departments in this question, on which no data were available, this extensive and difficult study on a three-year basis was undertaken.

Both the field work and the major part of the computation were completed during the year ending June 30, 1926.

Cost and practices were obtained from the chief producing areas of the state for alfalfa, clover, vetch, cheat and grain hay, corn silage, and kale. A total of 436 cost records for these products was obtained from 325 farms. In addition, the farm organization records were obtained from 96 of these farms in the irrigated sections.

The cheapest methods of making hay, the most efficient harvesting crews and equipment, the effect of yield and other factors influencing costs were obtained. Basic unit costs and the labor requirements for every operation and with different kinds of equipment were determined.

Organization of the irrigated farms and important factors influencing profits on these farms were also determined in connection with this study.

The survey and study will be repeated the coming year.

Purnell Project No. 4—Strawberry enterprise study. This project is carried as a cooperative investigation by the departments of Horticulture and Farm Management. In connection with a study of production methods in this enterprise by the department of Horticulture it seemed desirable, because of the value and rapidly growing acreage of this crop, that a preliminary study of the cost of production be made. In connection with the field work on the enterprise, the department of Horticulture obtained the records and the department of Farm Management prepared the survey forms and made the computation studies.

Records were obtained from 48 farms in the Willamette Valley covering the 1925 crop on 198 acres of bearing fruit, producing 698,000 pounds of berries. The average total area per farm was 59 acres, of which 4.1 acres were bearing strawberries and 2.8 acres were non-bearing strawberries.

The effect of soil type, yield, and other factors influencing cost, the labor requirements for every operation in strawberry production, and the cost of establishing a planting, were obtained.

The continuance of the study on a more thorough and complete basis seems desirable.

Fiber flax enterprise study. This project is carried as a cooperative investigation by the departments of Farm Management and Farm Crops.

Fiber flax is being rapidly developed as a new enterprise in the Willamette Valley. The quality of the product is superior. Manufacturing plants have been established. Early evidence as to the profitableness of the enterprise and the factors in cost of production which must be watched is of great importance to the development of the enterprise and the manufacturing industry.

As a preliminary study of the costs and methods of producing fiber flax, records were obtained from 50 representative farms for the 1925 crop in different sections of the Willamette Valley covering the costs and methods on 1,359 acres of fiber flax yielding a total of 1,542 tons of fiber. All computation work was completed.

The major factors influencing costs and profits, such as yield, type of soil, drainage, time of planting, etc., were clearly indicated.

As the enterprise becomes more fully established a more complete study of the factors controlling costs should be made.

Wheat enterprise study. This project is carried as a cooperative investigation by the departments of Farm Management, United States Department of Agriculture, and Oregon State Agricultural College Extension Service. This was a study of the cost of wheat production and the wheat farm organization on 150 wheat farms in Eastern Oregon for three years in succession. A total of 160,000 acres of wheat land producing 3,800,000 bushels of wheat was covered.

Work done. During the biennium the computation work on this project was completed and two manuscripts prepared, and a revision of them for popular distribution worked out.

EQUIPMENT AND FILING SYSTEM

During the biennium a complete filing system for all field records, office sheets, and tabulation summaries and reports has been prepared and installed so that all records are permanently filed for easy access and use.

Electric calculating and tabulating machines, a laboratory for computation work, and tables and other equipment have been installed.

DEPARTMENT OF HORTICULTURE

ADAMS PROJECTS

The following four headings cover the Station investigations under Adams Project funds:

The relation of general pruning practices and the resulting responses to the internal food changes in the tree as a whole. This work was begun in 1918. Results of this study have been chiefly of a general nature. It has emphasized the necessity of studying the pruning practices needed for each variety of tree, and the dangers underlying summer pruning. The specific data include cover crop and growth records, starch transformation, total nitrogen and carbohydrates of the leaves and root studies.

Effects of ringing and defoliation on the chemical and external activities of apple branches. The external responses to various combinations of ringing and defoliation are very interesting; in general, they are as recorded four years ago from a preliminary experiment carried out by A. E. Murneek. Since then considerable experimental work has been done on this problem from a more detailed chemical basis. In some respects the results obtained to date appear very promising.

Study of the distribution and function of phloridzin in apple and pear shoots. This work was begun four years ago. It was initiated through the questioning of conclusions of Mitra that maltose is very common in apple tissue. Mitra had reported the presence of large quantities of maltose in apple branches and spurs. He had also developed an elaborate physiological theory to explain its presence and function. The results of this work go to show that maltose is not present in such tissues, the substance taken for maltose being phloridzin. More detailed and extensive studies were then made of phloridzin in relation to growth, the results being published as Station Bulletin 215, Phloridzin, Its Significance in Apple Tissue. The problem has recently been followed up by micro-chemical studies of the exact distribution of phloridzin in differently functioning tissues.

Growth correlation of apple and pear shoots in relation to nutritive supply. This problem involves methods of attack somewhat similar to previous studies of the laboratory, that is to say, ringing and defoliation and chemical examination. The problem has grown out of previous work, however, and demands a number of changes in methods of attack. It is believed to have a very vital relation to the general pruning problems of this Station. Work has been in progress for nearly two years.

PURNELL PROJECTS

Economics of strawberry production. (Purnell Project No. 4.) Work on this project was begun July 19, 1925. The object of the study is to determine (1) the yield and price necessary to attain in order that growers and packers may produce a profit; and (2) ways in which production can be assisted to insure a larger supply of berries over a period of years. With the assistance of the Farm Management department, an outline covering the various phases of cost of production and marketing was drawn up. This outline was used in making some sixty surveys during the winter and early spring of 1925-26. During the fall of 1925, soil type determinations were made by the Soils department. The project will take at least one more year and possibly two before sufficient data can be assembled for a profitable analysis of the strawberry business.

Fruit harvesting and handling. (Purnell Project No. 3.) Work on this project during the biennium has been confined largely to the harvesting, shipping, canning and storing of sweet cherries, Italian prunes, pears, apples, and red raspberries.

This work has been reported on in part in Station Bulletins 206 and 126, and in Station Circulars 61 and 75, which have already been reviewed in this report.

The storage research work with pears is being continued at Medford and at Corvallis, the greatest amount of attention being given to the Bosc variety.

During the past year, investigations in the harvesting of sweet cherries similar in scope to those outlined in Station Circular 61 have been carried on. Results obtained from the work of the last year seem to confirm observations previously made. The work is being continued.

The work on harvesting of Italian prunes as reported in Circular 75 is being continued another year.

Preliminary investigations on the harvesting of red raspberries were begun in Hood River Valley in the early summer of 1926. Difficulties have been experienced by growers and cannerymen in arriving at the proper time of picking this fruit. The work will be continued another season at least.

Standardizing dried prunes. (Purnell Project No. 6.) Work on this project was begun in 1925. The object of the experiment is to determine whether prunes can be standardized so that they can be sold on a quality basis as well as on a size basis.

A large number of samples of dried prunes have been collected from various parts of the state. These samples have been tested for sugar and acid content. Moisture is one of the important factors bearing upon spoilage by mildews; tests have been made to show the amount of moisture in samples. Methods of processing to sterilize completely the dried fruit and to kill eggs and larvae of insects are being developed. The project will be continued until definite results can be announced.

Pear enterprise study. (Purnell Project No. 2.) A study of the status of the pear industry as a whole, both at home and abroad, covering such matters as total production, yields, distribution, marketing of fruit, production, prices received, etc., was begun in 1925. The purpose of the investigation is to obtain data which may be used in telling growers what varieties are best to plant, what yields are profitable, best methods of handling for various markets, the chances for export, etc.

Considerable valuable information was brought together, the results of which were presented at the annual meeting of the Oregon State Horticultural Society at Medford, 1925.

This project will continue one more year at least, and possibly two. The information will combine with that from the pear enterprise study reported under Farm Management as Purnell Project No. 2.

POMOLOGY PROJECTS

Cherry pollination. This project was begun in 1922 and has recently been brought to a close. The result of the work may be found in Station Bulletin 212, Pollination and Growing of the Cherry, which has been reviewed briefly in this report.

Growers are now gradually working over enough trees to furnish pollination for commercial varieties. Due to confusion in nomenclature

on sweet cherries found in the experimental work, growers have been compelled to test their own trees for the performance record, or are using certified material for the top-working of old trees or the propagation of young trees.

Sour cherries. The work of Mr. L. A. Fletcher, for the yast two years graduate student in Pomology, under the direction of the department, has brought out the fact that there is a strain of self-fertile Montmorency cherry. It had been previously believed that the Montmorency as grown in Oregon was entirely self-sterile. This discovery will eliminate the necessity of interplanting the Montmorency with other varieties for pollination purposes, whenever a self-fertile strain is used.

Walnut seedlings. In order to develop the best varieties of good quality and good growing habits which may be used to interplant with the Franquette, a test of a number of walnut seedlings has been carried on for the last two years. Two seedlings have been found up to the present time that merit close watching in the future. It is hoped to enlarge the scope of this work and continue it indefinitely.

Breeding work with fruits. The work of testing the seedlings, begun 12 to 15 years ago, is being continued with the cherries, apples, and pears. Nothing very promising has been found among these yet. The light colored cherry seedlings have shown a tendency to a dark colored juice that is detrimental in canning. Some very early ones are possibly of value for trial in early sections.

Only a few of the apples and pears have been saved as worthy of continued observations.

The strawberries have been showing better results in breeding and several will be sent out to growers this fall for trial on different soil types.

Improvement of prune orchard conditions. At the request of Salem growers of Italian prunes voiced through their Chamber of Commerce, an experiment was started in the spring of 1926 to determine the cause of a devitalized condition and poor yield of many of the old orchards in the vicinity of that city. The department of Soils is cooperating in this experiment. The investigation takes up the response of trees to cover crops, fertilizers, and pruning. So far, a marked difference is to be noted where the trees have been pruned vigorously, in contrast with those unpruned.

Influence of irrigation on small fruit production. This project was started in the spring of 1926 and will be continued indefinitely. So far the work has not gone far enough so that anything can be reported.

Miscellaneous. Of the seedling apples sent in to be tested, one has shown up worthy to be sent out for further testing in the state.

A variety, climatic, and soil test of the eastern blueberry, *Vaccinium corymbosum,* was begun during the summer of 1925. The plantings of the United States Government at Whitesbog, N. J., were visited, and through the cooperation of J. J. White Co., Incorporated, Whitesbog, N. J., sever-

al varieties were shipped to this coast in the fall, and are being tried out near Waldport, Oregon. It is too early to report anything more than that the plants are doing well in their present environment.

Studies in cranberry growing in Clatsop and Coos counties have been made during the past year. A bulletin will be published shortly giving the conclusions of these studies.

VEGETABLE GARDENING PROJECTS

Greenhouse tomatoes. Observations regarding the yields of tomato plants under glass as related to pollination have been under way for several years. Different methods of pollenizing the blossoms have been used. Varieties vary considerably in their natural blossom sterility. Some varieties such as "Best of All" have shorter pistils than "Bonny Best" and other varieties which are more easily hand pollinated. This variety more than compensates for this deficiency by its natural tendency to produce pollen heavily and to set more fruit without artificial aid than some other varieties with longer pistils.

Low yielding plants in the experiment producing from 3½ to 7 pounds of fruit and bearing only 15 to 25 specimens were obtained when pollination was either lacking or not thoroughly done.

High yielding plants produced 18 pounds and 10 ounces as a maximum, and bore 40 to 50 tomatoes per plant when consistent hand pollination was followed. The labor costs of careful pollination were found not to exceed 5c per plant for the entire pollination season.

Fall grown tomatoes have proved to be as commercially valuable as any greenhouse crop grown at the Station during fall and winter.

Variety tests. Work on beets has been under way since 1924.

Under similar cultural conditions, beets vary considerably in interior color, making desirable or undesirable roots for canning.

Tests of numerous strains of Detroit Dark Red show that strains having most uniform color throughout the field produce 85 to 90 percent usable roots. Inferior strains average 55 to 65 percent free from light zoning. Other factors such as soil types, fertilizers, and season are being observed as relating to root color. This work will be continued during the coming year.

Experiments with early cabbage have been undertaken for the past three years.

Maggot control has been found possible to the extent that 90 to 95 percent of plants have been treated with the use of tarred paper disks set around the plants at the time of transplanting to the field.

Check rows untreated gave 86 percent of unproductive plants killed by maggots.

Golden Acre is a promising variety of considerable commercial value. This experiment is to be continued for another season.

Heavy, solid heads of improved strains of late cabbage have 26 percent less core formation than light (not solid) heads from inferior

strains planted under similar conditions. Heaviest weight is directly proportionate to small core formation and inherent tendency toward light leaf folding.

Varieties of sweet potatoes planted for testing for the first time this season are: Triumph, Nancy Hall, Extra Early Golden, and some others. These are being grown under irrigation. No report can be given of this work before the fall of 1926. The work will be continued indefinitely.

Trials of head lettuce seed strains of the New York variety, the most widely grown commercial spring and fall crop, were begun this year. The experiment shows that variations take place in marketable heads from 88 percent in superior strains to 40 percent in inferior strains. All strains alike were subject to two uncontrollable factors such as "tip burn" and "slime." This work will be continued.

Varieties of cannery tomatoes are being grown for the first season to observe relative season, yield, market quality, and canning characters. No report can be made until the fall of 1926.

Irrigation of crops. A gravity irrigation system was installed in the spring of 1926. The object of this project is to obtain data on the cost of operating, the overhead charges due to irrigation, and the comparative yields on irrigated and non-irrigated areas. Previous irrigation tests with overhead sprinkling system have shown considerable value in forwarding early spring crops and making possible the following rotations: early lettuce followed by cauliflower, early cabbage followed by celery, spinach followed by peppers, and late cabbage succeeding early beets and carrots. No data are yet available. The work will be continued.

HORTICULTURAL PRODUCTS

Drying of walnuts. Work was begun in 1923 and was continued throughout the season of 1924. The object of the investigation was to find a more rapid and economic way of drying walnuts. The recirculation air drying system as used in the drying of Italian prunes was employed with certain modifications.

The drying was carried on at McMinnville in the plant in cooperation with one of the large growers of that region.

It was found that the successful drying of walnuts was dependent upon the three factors: temperature, circulation of air, and humidity. If the dried product contains too large an amount of moisture it will mold; if dried at too high a temperature it will become rancid.

The method involved in the experimental unit was forcing warmed air over the nuts piled in a bin three feet deep. The air was passed over them at a speed of from 700 to 800 linear feet per minute. This was accomplished by using a No. 9 fan run at 375 revolutions per minute, delivering 36,000 cubic feet per minute, and the air recirculated to save fuel. Since no traying was necessary, the handling cost in this operation was reduced to a minimum. The washing done previous to drying was handled in a home-made scrubber made from fiber mats attached to a

belt. The dragging of this belt above a stationary mat scrubbed the nuts, the nuts being in the water the entire time until being delivered to a slat conveyor to be dumped into the bins. The bins in this instance held five tons of walnuts and drying took place in approximately 24 to 30 hours.

The following table gives a good comparison between various types of driers as to the drying rate:

	Temperature	Percent humidity	Drying time
		%	*hrs.*
Oregon tunnel drier	95° F.	3-4	52
Kiln drier	95° F.	4	49
Recirculated Oregon tunnel	95° F.	5-8	38
Recirculated bin type	95° F.	8-10	30
With increased temperature increased drying rate was effected:			
Oregon tunnel	100° F.	3	50
Recirculated tunnel	100° F.	7	36
Recirculated bin	100° F.	10	26

In most of the drying carried on the temperatures used were 100° F. to 110° F., although one lot was dried at 120° F. to see what effect higher temperatures would have.

The high temperature in this case caused such rapid drying that splitting of the shells occurred. This, therefore, was not a feasible temperature to use, although no marked defects occurred in the flavor.

Driers of the recirculated bin type for the drying of nuts can be readily built in any size and capacity. The cost of drying with these units runs approximately $5.50 per ton. This is much cheaper than walnuts can be dried under natural draft conditions, the cost in these driers running as high as 1 cent per pound, which does not include the interest on invested money or the depreciation. Where recirculated air tray driers are used, the cost varies from $8.00 to $10.00 per ton.

Cut-out tests on canned fruits. This experiment was begun with the canning season of 1925. Due to the length of time needed for the work on the Standardization of Prunes, this project had to be held in abeyance during the season of 1926. Some interesting factors have been brought out, however, in the experiments of one season.

The fruit was canned following the standards issued by the Northwest Canners Association. An exact amount of fruit was carefully weighed into each can and to this an exact amount of sirup was added of a density required for the various grades according to the Northwest standards. Volume tests were made on the uncooked fruit to determine the percentage of shrinkage. So far, the results show very little variation in the cut-out of the sirup from the beginning to the end of the picking season. This is due primarily to the fact that various crops of fruit are coming in at varying times, making the percentage of ripe and partly ripe fruit approximately the same at all times. This work should be continued preferably on fruit coming from one source of supply during the season, to find out, if possible, whether or not the variations in season will affect the fruit and sirup cut-out.

Effect of spray upon perforation in canned goods. For the past two years a cooperative project on the effect of spray on the perforation in canned goods has been conducted with the department of Botany and Plant Pathology. The crops canned were gooseberries and cherries. It was found that sulfur spray residues on fruit gave a high percentage of spoilage.

Canning tests with new varieties of strawberries, cherries, and vegetables have been carried on through the past biennium.

Dehydration and dehydrators. This project is carried as a cooperative investigation by the Horticultural Products section and the Oregon Committee on Relation of Electricity to Agriculture. The object is to determine the cost and efficiency of operating driers and comparative cost data on operating driers with fans driven by electricity, gasolene, and natural draft.

An extensive survey has been made the past two years, and much data have been collected from all modern types of driers as well as the older styles. These data will be compiled and written up in bulletin form this fall. Much data showing the increase in electrical consumption since fans were beginning to be put in in 1920 to 1926 will be shown. Electrical power has been strongly advocated by this department for the use of driving fans in driers because it is more economical than gasolene for motive power and requires less attention.

The bulletin will discuss in full the use of power for this purpose, as well as a thorough analysis of drying with fan systems, giving points on drier operation for farm use.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

Virus diseases of potatoes. Work has been continued during the biennium on identification, rate of spread, and effectiveness of different methods of control of the different virus diseases. The virus diseases are identified only on the basis of symptoms and performance. Because symptoms are modified by climatic conditions accurate identification is sometimes difficult. Growth of the diseases under parallel conditions is enabling an accurate determination of symptoms to be made. Rugose mosaic, mild mosaic, leaf-roll, witches'-broom, giant hill, and calico are the only virus diseases which have been specifically identified as occurring on potatoes in Oregon.

Of these, rugose mosaic spreads more rapidly than the others, and is more difficult to control. Considerable progress has been made in determining the effectiveness of different control measures. Roguing must be done early and thoroughly to be at all effective. Two plots planted with sets from the same tubers and rogued differently gave the following figures. Starting with approximately 12 percent rugose mosaic in each case and roguing early and at different intervals throughout the season in one case the percentage of disease the following year was reduced to 5.4, and in the other case roguing only twice late in the season the percentage of disease the following year had even increased to 16.4.

In another plot containing 4.5 percent rugose mosaic the amount of disease was reduced by early and repeated roguings to 2.2 percent the following year. Apparently at best roguing can be depended on only to hold the percentage of disease to a low figure, but can not be relied on for complete elimination of the disease from the seed plot. Roguing can be done more effectively on a tuber-unit planted than a mass planted seed plot.

Apparently complete elimination of the virus diseases can be effected only by eye indexing the tubers for the foundation seed stock. By growing in advance of the regular planting season one eye from each tuber as an index of the health of the tuber apparently the virus diseases can be eliminated. It is then only a question of growing these disease-free stocks in isolation from other potatoes to maintain them in a healthy condition. In every locality where home-grown seed can be maintained in good, productive condition from year to year the use of a tuber-unit planted potato seed plot should become a part of the general practice of every farm.

A part of the work on potato virus diseases is now being conducted in cooperation with the United States Department of Agriculture.

Virus diseases of bramble fruits. Continued observations of these troubles over a period of years have revealed that their detrimental effects are not so pronounced as in the more humid and warmer climate which prevails in the eastern and middle western sections of the United States. As previously reported, the severe mosaic as found in the East does not occur to any marked extent in Oregon. On the other hand, a mild type of symptom (which has not yet been transmitted or proved definitely to be a virus trouble) occurs widespread in the loganberry, blackberry, and black raspberry plantings. This is most frequently found in plantings of loganberry and Kittatinny, the latter of which is generally affected, but is sparingly planted in Oregon. This mild type of symptom does not affect to a marked degree the vitality of the affected plants.

Streak is found in certain plantings of the Cumberland black raspberry, and its introduction into the state traces back to stock from New York State. This disease has been under observation for four seasons, and during this time affected plants show no apparent decrease in vitality. Under our climatic conditions the symptoms are masked for most of the year, showing slight mottling of the leaves in early spring and seldom showing streaking of the canes, which occurs in late summer.

Blackberry dwarf has been transmitted from diseased loganberry plants to caged healthy loganberry plants by means of aphids from the sweet briar rose, *Rosa rubiginosa.* The aphids were allowed to feed for several days on succulently growing loganberry plants affected with the dwarf disease and were then transferred to the young leaves of healthy loganberry plants grown under cages. Slight or severe necrosis along the veins and margins of the leaves resulted within 6 days, and all growth since this necrosis appeared has exhibited the symptoms of dwarf for two seasons. These transmission experiments have been successfully repeated during the second summer. When the aphids were

transferred from healthy loganberry plants to healthy loganberry plants, the latter have had no symptoms of the dwarf disease. Roguing is effective and practical as a control measure where the percentage of diseased plants is very low (5 percent or less). Growers should plant disease-free stock. The Phenomenal blackberry, since it is very susceptible, should not be commercially planted. One planting of 600 Phenomenal plants in Coos county was reported to be 100 percent affected.

Webbing and penciling are not thought to be virus troubles, for they do not persist in the same plant from season to season.

Attenuation of leaves, especially in black raspberries, is sometimes accompanied by a peculiar mottling of the leaves. This attenuation, however, is not thought to be the expression of a virus trouble. It has been found associated with such root troubles as (1) poor drainage or high water-tables in heavy soils, (2) Verticilium wilt (blue stem), and (3) attacks by strawberry crown-borer.

During 1923 healthy stock was marked, and in the spring of 1924 this was planted on Kiger Island. This planting contained 228 plants of Cuthbert red raspberry from a Corvallis planting, 57 plants of Cayuga red raspberry from New York; 59 plants of Seneca red raspberry from New York; 168 plants of Plum Farmer black raspberry from Corvallis; 45 plants of loganberry from Douglas county.

The spring and summer of 1924 were warm and dry so that symptoms were masked from the start. Only 0.66 percent of the reds were rogued in 1924. In the spring of 1925 the weather was cooler and symptoms were observable, and 6 percent of the red raspberry plants were rogued. These undoubtedly were missed the previous season. In 1926 the planting was clean of virus symptoms except a little webbing in the black raspberries. These results show that by the careful selection and planting of virus-free nursery stock clean plantings can be maintained under Oregon conditions. This is facilitated by the fact that there are few aphis carriers to be found on the bramble fruits in Oregon.

Perennial canker. During the biennium this disease has been identified, the causal organism described as new, and a preliminary bulletin, Agricultural Experiment Station Bulletin 217, Perennial Canker of Apple Trees, was published. At the present time attempts are being made to find the ascogenous stage of the fungus, to learn definite field distinctions from apple tree anthracnose, to learn some phases of the physiological performance of the causal fungus, and to follow the development of the canker after inoculations. The superintendent of the Hood River Branch Experiment Station is studying methods of eradication and prevention and the relation to winter injury and woolly aphis infestation.

Bulb diseases. During the past few years the bulb industry has developed rapidly here. Important diseases have been encountered for which control measures are needed. A project has been initiated on bulb diseases and their control in cooperation with the United States Department of Agriculture. Some preliminary progress has been made, of which the following is a brief summary:

Narcissus nematode. This has proved a destructive disease in the few places where it has occurred. Crop rotation and treatment of the bulbs with hot water before planting are the chief methods of control as developed in Europe. The standard treatment with hot water as used is 110-111.5° F. for two and one-half hours. This treatment, however, has given a little less than complete control of the disease here. Possibly further tests may show that the temperature will have to be increased slightly to give perfect control. Golden Spur narcissus bulbs were treated as high as 116° F. for three hours and grown successfully. This treatment was given when the bulbs were well matured and quite dormant. The standard hot water treatment caused no injury to the bulbs, but seemed even to give stimulated growth as compared to normal untreated lots.

Narcissus mosaic. This disease, characterized by a yellowish mottling in the leaves, and often called the grey disease, has been noted in varying amounts in several varieties in different plantings. The percentage of disease is usually small, though as high as 25, 60, 82, and occasionally 100 percent of the plants have been found affected. Affected plants are somewhat weakened due to a reduction in the efficiency of the chlorophyl, resulting in slower increase in weight of the bulb and in the number of bulbs produced when propagated. Apparently the disease does not spread rapidly in the field and may be successfully avoided by selection of the propagating stock.

Tulip fire. This disease has long been known to the tulip growers. Affected plants from diseased bulbs are frequently killed prematurely, and from these the fungus spreads under favorable conditions to healthy plants, causing spotting of the foliage and flowers. Control methods as used consist in a three-year rotation, roguing of badly affected plants, and thorough cleaning of the bulbs before planting. There is no doubt of the advisability of the general use of these methods. Tests are being made to determine whether any treatment of the bulbs with a fungicidal before planting and whether any spray applied to the foliage during growth would be feasible methods of control.

Tulip mosaic. In tulip flowers there is a very striking condition in which the color is irregularly distributed in the petals, commonly referred to as "breaking." The foliage on such plants also generally shows an irregular mottling of the chlorophyl. Almost certainly this condition is due to an infectious mosaic disease. Tests have been started to determine whether this condition can be produced in healthy plants by inoculations and by transfer of aphids from affected to healthy plants. Affected plants can be grown quite successfully, though the increase in size of the clumps of bulbs is noticeably smaller than in the case of normal plants. When this trouble occurs in tulips it requires careful roguing during the growing season to remove it from the stocks, or it necessitates the disposal of the bulbs as a mixed lot, since the color and condition are not normal for the variety. As high as 17 percent of broken flowers has been noted in some commercial stocks and much higher percentages in some private plantings. No tulips showing broken flowers should be allowed to remain in beds of commercial stocks or be grown in close proximity to normal tulips.

Fungous diseases of brambles. Verticillium wilt (blue stem) of black raspberries has been found prevalent in the berry growing districts. The causal organism can not be distinguished from the organism (*Verticillium albo-atrum*) causing Verticillium wilt of potato. In fact, circumstantial evidence points to the probability that they are even the same strain. Black raspberries planted on soil which was in potatoes the previous year usually begin to have a high percentage of mortality the third year, and potatoes planted on such land cleared of black raspberries do not yield commercial crops due to Verticillium wilt.

Mildew of brambles does not affect to a marked degree any of our commercial varieties except the Munger black raspberry, which is usually seriously attacked. Some spraying and dusting with sulfur-containing materials have had preliminary tests, but a suitable control has not been found.

Rust. The Western raspberry rust caused by *Phragmidium imitans* Arthur is serious on the Cuthbert red raspberry according to seasonal conditions. Its life-history and morphology are now being worked out jointly with Doctor B. O. Dodge, of the Bureau of Plant Industry, United States Department of Agriculture. Usually rusts are not controlled by dusting or spraying, but if the complete eradication of old diseased leaves and last year's fruiting canes is accomplished each year this disease should be kept down to a minimum. Our suggestions are to remove the old canes before the new ones appear, cutting the canes very low so as to leave as short stubs as practical and plow under the old leaves after they have all fallen, preferably very early in the spring. Burn all brush immediately after removal.

Strawberry disease survey. Beside the work of our regular projects a preliminary survey of disease conditions in strawberry plantings has been made. The "yellows" described by Mr. Plakidas, of California, (Phytopathology 16: 423-426. 1926) has been found very scatteringly if at all in our survey, although Mr. Plakidas has found the disease in Douglas county, Oregon, a district which we did not visit in our survey.

On the other hand, another set of symptoms which we have called "crinkle" in the varieties Marshall, Nick Ohmer, Magoons, and New Oregon, and a "witches'-broom" effect in the Ettersburg 121 have been found scatteringly in Marion and Multnomah counties. These symptoms are suspected to be those of a virus trouble, although their transmission to healthy plants has not been accomplished. Both healthy and diseased plants have been placed in insect-proof cages, and transmission experiments have just begun using the strawberry leaf louse as an agent.

Smut treatments for wheat. The work reported on in the last report showed the distinct advantages of copper carbonate used as a dust over the previously general wet methods of treatment. The fact that mercury-containing compounds were of distinct value in grain smut control in some instances and not in others was also brought out. In the fall of 1925 another series of tests was planted out, using the rod row method replicated as before, but using a different variety of wheat and a much wider range of treating materials of different commercial brands.

The effects of different degrees of smutting were tested and different rates of application as well in the case of the dusts. The final counts on this series are not yet complete.

The effects of fungicides on the keeping of canned fruits. In the last biennial report preliminary work was mentioned in which the fact was brought out that swelling of cans would result in the case of gooseberries sprayed with lime-sulfur or dusted with sulfur dust. During the past two years other tests have been carried out in cooperation with the Horticultural Products laboratory with a view to extending our knowledge of the effects of other fungicides on gooseberries and also on other fruits canned in the usual commercial way. The 1925 tests showed that in ten months no trouble developed in canned gooseberries even when subjected for many weeks to about 100° F. when the berries had been sprayed before canning with home-made bordeaux, 4-4-50, or the equivalent strength of a certain commercial bordeaux, or with sodium carbonate 1½ ounces per gallon of water, or with a commercial copper-lime dust. The results were the same whether plain or enameled cans were employed.

In 1925 sweet cherries were also treated two weeks before canning with applications of the following materials: New Jersey dry-mix sulfur and lime, dusting sulfur plain, and dusting sulfur with lead arsenate. In no case did swelling develop except with one can of plain sulfur-dusted cherries which showed slight swelling at the last observation nearly a year afterward. Yet in a more severe test with cherries conducted the same year, fruit dusted with sulfur began to give hard swelling in about 4 months, while bordeaux sprayed fruit gave no trouble until eight months or more had passed. In this last test the fruit was treated the day before it was canned by dusting or spraying the picked fruit spread out on a floor. When canned this fruit was not washed as in the other case. These results with cherries indicate some danger from sulfur applied under conditions which prevent weathering off, but little or none from bordeaux.

In the spring of 1926 further canning tests were begun with cherries as sprayed in the orchard by growers using different materials. In the fall, tests of a similar nature with prunes will be made.

Effects of fungicides on the development of decay in fresh fruit under transportation and storage conditions. On account of the prevalence of brown rot and other decay-producing fungi in Western Oregon and because of the rapid deterioration of unsprayed fruit when transported in some seasons to distant markets, it was deemed desirable to make a study of the value of orchard spraying or other treatments on the keeping quality of cherries and prunes from this section. Preliminary work was begun in June, 1926, using lots of cherries supplied by various growers. Prunes will be used later in the season. Results are not yet ready for the drawing of final conclusions.

A new bacterial disease of tomato. Some preliminary studies were made in 1925 of a new vascular bacterial disease of tomato which appeared about Corvallis in that year, causing a small amount of damage on the whole, but destroying most of the plants in a few home gardens.

The organism which was isolated appeared to differ from any described bacterial pathogene of tomato. Cultures were sent to Miss Nellie A. Brown, of the United States Department of Agriculture, who confirmed this conclusion. A few tests by pure culture inoculations indicate that the bacteria are only weakly parasitic, although capable of producing a sort of wilt under certain conditions. Suppression of the disease took place naturally in the field late in the season of 1925, some plants outgrowing the infection and producing yields on branches that escaped early attack.

The relation of the number of stomata to susceptibility of species of Ribes to pine blister rust infection. The technique of making microcounts of stomata was worked out, and a relatively limited number of leaves of 5 species of Ribes were examined. In respect to the abundance of stomata per unit of leaf area the species ranged themselves in descending order as follows: *R. bracteosum, R. nigrum, R. sanguineum, R. divaricata,* and *R. cereum.* Although the natural susceptibility of the last named is not known and the precise relative susceptibility of some of the other species to the white pine blister rust is not yet established beyond question, yet field observations point to *R. nigrum, R. sanguineum,* and *R. divaricata* as being susceptible in the same order as that established by their respective stomata counts. This work constitutes purely a preliminary step which should be repeated and extended before any conclusions as to true correlation can be drawn.

Copper-lime dust vs. bordeaux spray for control of apple-tree anthracnose canker. Through the cooperation of G. E. Tower of Salem, we were able to get a check on the comparative efficiency of two applications of copper-lime dust applied in July and August respectively as compared with one application in July of home-made bordeaux mixture 4-4-50, for the control of apple-tree anthracnose canker infections, in an orchard that showed considerable damage from the disease to begin with. The canker counts made in the fall of the old cankers and those made in the spring of 1925 of the new ones, showed that there had been very effective control by the liquid application but little or none by the two dust applications.

DEPARTMENT OF ENTOMOLOGY

DECIDUOUS FRUIT INSECT INVESTIGATIONS

The value of casein spreaders in insect sprays. The spray used in this test during the biennium was lead arsenate. The spreaders used were skim milk and a commercial casein spreader. The tests comprised: (1) Testing the comparative amounts of poison carried into the calyx cup of apples by a calyx spray of lead arsenate with and without casein spreaders. (2) Testing the efficacy of the cover sprays of arsenate of lead with and without casein spreaders in preventing worm entrance. (3) Field tests of calcium caseinate spreaders to determine the effectiveness of spreaders in combating codling-moth under actual field conditions as applied by the grower.

The results indicate: (1) Chemical analyses in 1924 and 1925 show a definite increase in the amount of lead arsenate in the calyx of apples

when "spreader" is used as compared with apples sprayed without "spreader." (2) Field tests in 1924 and 1925 showed no distinct advantage in worm control where casein spreaders were used over apples sprayed without "spreader." (3) Laboratory tests showed no advantage in preventing worm entrance where casein spreaders were used as compared with apples sprayed without spreaders.

Codling-moth studies. The codling-moth is by far the chief insect pest causing apple and pear losses in Oregon. The life-history of the codling-moth in Oregon has been approximately known for years and general methods of control practiced. Yet many fruit growers have been confronted annually with considerable losses. This fact, together with numerous requests for information upon control, has led the Station to undertake spray tests and codling-moth studies with a view to obtaining the information needed for adequate control of the codling-moth.

Beginning with 1924 a complete seasonal history of the insect at Corvallis has been followed. Some of the more important events in the life-history of the insect, as recorded for the two seasons, are summarized as follows:

	1924	1925
First adult moths observed	April 25	May 4
First eggs observed	May 15, 16	May 15
First temperature 60° F. or above at 8 p.m.	May 14, 15, 16	May 13, 14, 15
Temperature below 60° F. at 8 p.m.	May 17-26	May 16-24 and May 27-June 17
Eggs next observed	May 27	May 27
Seasonal temperatures 60° F. or above at 8 p.m. began	May 27	June 18
Main egg laying began	May 27	June 18
First moth 2nd generation observed	August 10	July 8
Peak of 2nd generation moths	July 12	August 12

It will be observed that the moths apparently are very sensitive to temperature. They were observed to lay no eggs until the twilight temperature on several consecutive evenings was 60° F. and above. These observations are of practical value in timing the spray applications for most effective results.

The Syneta fruit beetle *(Syneta albida* Lec.*)*. This insect continues to be prevalent throughout the Willamette Valley and to constitute one of the serious pests of the cherry. The Syneta beetle injures the stems and immature fruit of cherries so that the fruit either drops or becomes scarred so badly as to be unsalable as first or even second grade fruit. The damage during this biennium was even greater than that during the previous biennium. Control tests against this beetle were undertaken early in the biennium. It will be necessary to enlarge and intensify these tests if we are to obtain early returns. These tests indicate that a stronger solution than a standard lead arsenate solution (2 pounds to 100 gallons water) is necessary in order to control this pest, and that two applications should be made, one before blossoming and the second at the time the blossom petals are dropping. A partial summary of the

results of spraying experiments at Salem for the Syneta fruit beetle on cherries (1925) follow:

Spray formula	Time of application	Number of applications	Percent fruit injury
			%
Lead arsenate 4-100	Before and after blossoming	2	7.1
Lead arsenate 8-100	Before and after blossoming	2	6.0
Check—adjacent to the above sprayed plots		-	37.5
Calcium arsenate 5-100	Before blossoming	1	14.0
Calcium arsenate 5-100	After blossoming	1	28.1
Lead arsenate 5-100	After blossoming	1	12.4
Check—adjacent to the above sprayed plots		-	61.3

Prune thrips *(Taeniothrips inconsequens* Uzel*).* Many of the prune orchards in Marion county have had no good crop since 1918. Thrips are thought by some of the growers to be responsible for part of the trouble, and requests for control measures are increasingly numerous. In order to determine the most effective spray and the date or dates when the spray should be applied, experimental tests were undertaken this season (1926). Tests of oil emulsions, lime-sulfur, nicotine sulfate, and soap are being made.

MINOR FRUIT INSECT STUDIES

Control tests against the rosy apple aphid *(Aphis sorbi* Kalt.*).* In Western Oregon the rosy apple aphid is the most abundant species of the apple plant lice. Because of its high toxicity to the apple foliage and fruit it is a very serious pest. Furthermore, this species apparently appears in destructive numbers each year, making it imperative for the orchardist to include measures for its control in his annual spray program. This aphid spray is an exceedingly expensive one and it has not always given uniformly satisfactory results. In Western Oregon the hatching period for *Aphis sorbi* occasionally extends over a period of thirty days. Because of this fact it was thought that a spray somewhat later than the "delayed dormant" might give more uniform results.

The results of two seasons' tests are summarized as follows:

AVERAGE INFESTATION—LEAF AND FRUIT CLUSTERS PER TREE

	Nicotine sulfate				Miscible oil	Oil emulsion	
	1-1200			1-800	4-100	8-100	
Time of application	First season	Second season	Average two years	Second season	First season	Second season	Check
Green tip	.....	.....	.....	.....	.....	3.75	20.25
Delayed dormant	11.26	2.66	6.96	2.83	10.66	.....	30.50
Pre-pink	.....	14.00	.....	15.40	.....	.....	29.75
Pink	14.25	24.00	19.12	14.75	12.80	.....	23.62

The results of these tests indicate that:

(1) Nicotine sulfate at a dilution of 1 to 1200 is just as effective as the stronger dilution of 1 to 800.

(2) The delayed dormant spray of lime-sulfur for scab and nicotine sulfate is more effective than the pre-pink or pink spray. The term

delayed dormant as used in this discussion refers to a stage in the development of the foliage which may be described as the "rabbit ear" stage. This stage is really a later stage in apple development than is usually meant by delayed dormant.

(3) Oil emulsion applied in the green tip stage is as effective as the delayed dormant lime-sulfur nicotine-sulfate spray. Where scab control is a factor no advantage, apparently, accrues from the use of oil, since a later application of lime-sulfur would have to be made for scab control.

San Jose scale spray tests. Fruit growers are very much interested in the various dry powders and oil emulsions now offered as substitutes for the standard dormant spray of lime-sulfur solution against San Jose scale. The dry substitutes when used in strengths recommended by the manufacturer furnish less polysulfide sulfur than does the liquid concentrate used at standard dilution.

This condition led the Agricultural Experiment Station to initiate a test of these sprays in order to determine whether the dry materials are effective. Numerous inquiries concerning the oil sprays led the Station to include a test of the oil emulsions.

The materials were applied as dormant sprays and results were determined by microscopic examination of sprayed and unsprayed trees, the number of dead and living scales being recorded. During the course of the test more than 12,000 scales were counted as a basis upon which conclusions were drawn as to the effectiveness of the different materials and dilutions. The results of the tests follow:

SAN JOSE SPRAY TESTS (1925)

Insecticide used	No. dead	No. alive	Percent kill
			%
1. Brown Neutral Oil 8 percent emulsion	500	0	100
2. Brown Neutral Oil 4 percent emulsion	500	0	100
3. Brown Neutral Oil 2 percent emulsion	420	80	84
4. Check	45	455	9
5. Red Engine Oil 4 percent emulsion	500	0	100
6. Red Engine Oil Heavy 4 percent emulsion	500	0	100
7. Sherwin-Williams Free Emulsion 7.5 percent	1,000	0	100
8. Sunoco Spray Oil 7.5 percent	1,000	0	100
9. Dry Lime Sulfur 48 lbs. to 100 gallons water	1,000	0	100
10. Dry Lime Sulfur 24 lbs. to 100 gallons water	938	62	93.8
11. Dry Lime Sulfur 12 lbs. to 100 gallons water	765	235	76.5
12. Liquid Lime Sulfur 12 to 100	1,000	0	100
13. Liquid Lime Sulfur 6 to 100	992	8	99.2
14. Liquid Lime Sulfur 3 to 100	820	180	82
15. Dormant Dust (Niagara)	893	107	89.3
16. Check	50	450	10

Cherry-maggot survey. Requested by Mr. C. A. Park, President Oregon State Board of Horticulture. The purpose of this survey was to determine the limits of the distribution of the cherry fruit-fly (*Rhagoletis cingulata,* Loew.) in Southern Oregon. The information obtained was used by the State Board of Horticulture in establishing non-infested areas in Oregon in order that cherry growers and shippers in the non-infested districts may ship into California. Cherry orchards were examined in Lane, Douglas, Josephine, Jackson, Curry, and Coos counties. The fruit maggot was not found in Douglas, Josephine, Jackson, Curry, and

Coos counties. It is recorded as occurring in the Willamette Valley and in Union and Wallowa counties.

Prune root-borer *(Sanninoidea opalescens* Hy. Edw.*)*. Prune growers who for one reason or another have failed to treat for borer in early fall will be interested in the results of two years' tests with paradichlorobenzene applied in the spring. These results indicate that spring treatment with this chemical may be effective in the control of the prune root borer. Two years' observations, and one year's experimental tests indicate that paradichlorobenzene is not detrimental to trees under six years. This point is very important to the growers, for the younger trees are more severely injured by the borer than are older trees.

SMALL-FRUIT INSECT INVESTIGATIONS

Strawberry root-weevils. The strawberry root-weevils (*Brachyrhinus ovatus* L. and *Brachyrhinus rugosostriatus* Goeze) and the black vine weevil, (*Brachyrhinus sulcatus* Fab.), constitute one of the worst menaces to the strawberry industry in Oregon. Anticipating the availability, July 1, 1926, of aid from the Federal Government for a study of these pests, work on the weevils was begun early in March. Headquarters for the work were established in Hood River and Marion county districts, where the insect is prevalent and destructive. Tests of commercial and home-made weevil baits were initiated in the spring of 1926. These baits comprise ground apple waste or peelings mixed with various insecticides. Preliminary tests indicate that a home-made bait of ground apple waste 95 pounds, mixed with 5 pounds of calcium arsenate will kill from 95 to 100 percent of the weevils. This project will include comparative tests of other insecticides, dusts, poison bran baits, and time of application of bait, as well as life-history studies of the weevils.

Gooseberry insects. On account of the losses caused by the insect pests of gooseberries and in response to the urgent appeals from growers, canners, and others interested in gooseberry production, a project was established for the investigation of gooseberry insects. A preliminary survey of the insect pests attacking the gooseberry plant revealed two pests of primary importance, the black gooseberry borer and the gooseberry fruit-fly.

The black gooseberry borer *(Xylocrius agassizii* Lec.*)*. In some of our commercial gooseberry sections this pest is assuming serious proportions. Once the gooseberry plantings become infested, yields are soon reduced, and in a few years entire plants here and there throughout the fields are killed outright. In addition to the life-history studies of this pest, tests of paradichlorobenzene, calcium cyanide, and other soil fumigants for the control of this pest were undertaken. None of the soil fumigants except calcium cyanide proved of value in killing the borers. This fumigant, however, proved injurious to the plants as well. A report of these tests, together with information upon the life-history, is published in the Journal of Economic Entomology, Vol. 18, No. 5, October, 1925.

Egg laying was observed in the field this spring (1926) and tests of ovicides were initiated.

MINOR SMALL-FRUIT INSECT STUDIES

Gooseberry bud midge. A new insect found on gooseberries in Oregon was observed during the survey of gooseberry pests. This insect is known as the gooseberry bud midge *(Rhopalonyia grossulariae* Felt*)*. The plant is injured by the insect working during the larval stage in the dormant buds, causing them to blight and scale off the bushes. The gooseberry bud midge apparently is local in distribution and not as yet a limiting factor in gooseberry production.

Strawberry leaf-roller. An outbreak of the strawberry leaf-roller *(Ancylis comptana* Fröhlich*)* occurred during the summer of 1924 at Grants Pass. Specimens of the insect were collected and laboratory studies on the life-history of the insect were made. Last season (1925) a report of an infestation in Marion county was investigated with the result that a new strawberry leaf-roller not heretofore found or reported from Oregon was discovered. The scientific name of this new leaf-roller as determined by specialists of the Federal Bureau of Entomology is *Anacampsis fragariella* Busck. Each of these outbreaks was localized and apparently affected the yield but little.

ADDITIONAL INFORMATION NEEDED

Gooseberry and currant fruit-fly (*Epochra canadensis* Loew.). A limiting factor in berry production. Sometimes as high as 30 to 50 percent of the berries is infested. This season (1926) this fruit maggot was of even greater damage because of the extremely early season. Generally the flies come out during May, but this spring (1926) due to the advanced season they emerged much earlier than usual, a fact of vital importance in the control of this pest if sweetened poison baits are to be of value. Next season it is hoped provision can be made for testing the sweetened baits which are so effective against the cherry maggot fly.

Strawberry crown moth *(Synanthedon rutilans* Hy. Edw.*)*. The damage done by this insect, commonly called crown borer, during the biennium has been unusually severe. Not only have old plantings been destroyed, but in many cases one-year-old patches were attacked and seriously damaged. Growers and canners are urging the necessity for a study of this pest with a view to devising a more satisfactory control than is now known. Digging up and burning the infested plants is the only known control.

TRUCK AND GARDEN CROP INSECT INVESTIGATIONS

The onion-maggot *(Hylemyia antiqua* Meigen*)*. Studies of the life-history, extent of damage, and control methods are being continued. Results of last year's (1925) tests of corrosive sublimate, oil emulsion, and bordeaux-oil emulsion, substances sprayed on the soil along the onion rows with a view to killing the eggs and young larvae before they reach the onion, were not very conclusive.

The corrosive sublimate plot yielded at the rate of 353.41 pounds per acre.

The bordeaux oil emulsion plot yielded at the rate of 451.03 pounds per acre.

The oil emulsion plot yielded at the rate of 443.67 pounds per acre.

The check plot yielded at the rate of 414.46 pounds per acre.

MINOR VEGETABLE INSECT STUDIES

Beet leaf-hopper (*Eutettix tenella* Baker). In order to meet the need for information upon the distribution of the beet leaf-hopper and in response to requests from growers and others interested in beet sugar production a survey to determine the prevalence of this insect in Oregon was undertaken. The insect was found to occur in Crook and Deschutes counties and the following are native host plants: "Jim Hill" mustard *(Sisymbrium altissimum)*, Russian thistles *(Salsola kali* var. tenuifolia), narrow leaf nightshade *(Solanum nigrum)* and *Atriplex* sp. were generally distributed throughout the counties.

The seed-corn maggot *(Hylemyia* sp.*)*. Urgent appeals for assistance in the control of this pest (to our knowledge the first outbreak of this pest in Oregon) came from all four corners of the state in the spring of 1925. The first call for help came from the melon growers of the Umatilla-Irrigon District. Here the maggots attacking the cotyledons of melon and cantaloup seed and boring in the stems of sprouting seed had practically destroyed the first seeding and a partial second seeding on twelve acres. Damage was apparent in other fields, but not as serious as in this one field. Here an alfalfa sod plowed under in late spring appeared to be attracting the flies. The next reports of damage came from Lake county. The pest was reported on May 20, 1925, as attacking beans, barley, and wheat, destroying large areas of the latter in the Tule Lake beds. Later it was reported as destroying more than an acre of beans in Washington county and several acres of cucumbers in Marion county.

The results of the season's survey of the seed corn maggot epidemic indicate that the infestation is heaviest in cold, damp soil containing considerable decaying vegetable matter. Apparently the cold, wet spring of 1925 was favorable to the development of the pest in epidemic form.

The diamond-back cabbage worm *(Plutella maculipennis* Curt.). An outbreak of this insect occurred last summer (1925) on rutabagas at Astoria. The insect appeared in such destructive numbers on the Station farm that more than half the stand of rutabagas had been destroyed when the investigation was made the first of August. The insect was present in all stages from egg to adult, but nearly mature larvae were most numerous. The larvae eat small holes only in the under surface of the leaf, leaving the upper surface untouched. The upper surface dries and breaks, giving the leaf a shot hole appearance. Because of this feeding habit, control is exceedingly difficult as the under side of the rutabaga leaf must be covered with the poison spray. Laboratory control tests with the following mixtures were initiated:

(1) Paris green 8 oz., ½ pound slaked lime, 50 gallons water.
(2) Paris green—2 times the amounts used in (1).
(3) Kedzie mixture.
(4) Kedzie mixture double strength.

On plants sprayed with Nos. 2 and 4, 100 percent kill was obtained; on plants sprayed with Nos. 1 and 3, about 25 percent kill was obtained.

INSECT TRANSMISSION OF DISEASE

In the progress of the study of the virus diseases of brambles, potatoes, and truck crops made by the plant disease department here certain questions arise involving the identity of the insects implicated in disease transmission, the distribution of these insects in Oregon, laboratory and rearing cage methods of handling these insects, and the like. In so far as funds and time available permit, entomological aid in these virus disease studies is given. Preliminary surveys of potatoes and brambles with particular reference to those insects involved in disease spread have been made. The collection and observation of Oregon aphids were begun early in the summer of 1925 and have been continued through 1926. Aphids have been collected from some sixty-five host plants. Study and identification of these are now being made.

FIELD CROPS INSECT INVESTIGATIONS

Hop red spider *(Tetranychus telarius* Linn.*)*. On account of the serious outbreak of the hop red spider in 1924, and in response to requests from growers in the Willamette and Rogue River valleys for aid, several experimental controls with dusting and spraying materials were tried. Excellent results in red spider control were obtained both in the laboratory and in the field with the following formula:

Lime-sulfur (concentrated)	2 gallons
Dusting sulfur	5 pounds
Calcium caseinate spreader	1 pound
Water	100 gallons

Other materials tested with less effective results follow: (1) Lye-sulfur formula, (2) Colloidal sulfur 4-50, (3) Oregon Cold Mix, (4) Sulfur dust, (5) Soluble sulfur, (6) Sunoco oil 2 percent, (7) Red Engine oil emulsion 2 percent, (8) Volck oil 1½ percent, (9) Kerosene emulsion 1-15, (10) Linseed oil 1 percent, (11) Whale-oil soap 6 pounds to 100 gallons water.

Severe burning of the foliage resulted from the use of Sunoco, Red Engine, and kerosene oil emulsions. Volck oil, one of the so-called crystalline or summer oil types, compares favorably with the lime-sulfur dusting sulfur formula, but did not appear to be as lasting in its effectiveness. Uniformly effective results in combating red spider are not being obtained by all growers. This may be due in part to temperature conditions and in part to lack of thoroughness of application. A survey of many hop yards, however, showed that many growers were not achieving the thoroughness of application so necessary to successful spider-mite control.

MINOR FIELD CROP INSECT STUDIES

Alfalfa weevil survey. The inspection of alfalfa fields in Eastern Oregon to determine the spread of the alfalfa weevil was continued in 1925 by Entomologists of the Agricultural Experiment Station and the Federal Bureau of Entomology cooperating. No spread was reported for 1925. The weevil is now recorded as occurring in the counties of Malheur, Harney, and Baker.

Cutworms. During the summer of 1925 a serious outbreak of cutworms occurred throughout Oregon. The worms were most numerous in Western and Southern Oregon. Injury to bushes, ornamental shrubs, garden crops, flax, and alfalfa hay was quite serious. The injury became most pronounced in early July; reached its height by the last of July and then rapidly subsided. Severe damage occurred in alfalfa in Klamath county, where the entomologist was called to aid in combating the outbreak. A survey of the county on July 28 showed the worms to be quite far advanced, many having already pupated.

The variegated cutworm (*Lycophotia margaritosa* Hubn.) was responsible for most of the damage around Klamath Falls, Malin and south to Tule Lake, while the olive green cutworm (*Neuria procincta* Grote) was doing most of the damage in the Fort Klamath region. Another species (*Prodenia prefecta* Grote) was found in the Tule Lake region feeding mostly on weeds. Tests of various baits showed the earwig bait to be as effective as the standard cutworm bait of bran and white arsenic. Lead arsenate did not prove as effective in the baits as did sodium fluoride and white arsenic.

INSECTS AFFECTING BULBS AND FLOWERS

Bulb insects. In order to meet the need for information on the insect pests attacking bulbs in Oregon, their habits, distribution, and control measures, this project was undertaken late in the biennium. Already some information on the lesser bulb fly (*Eumerus strigatus* Fallen) as an onion pest had been obtained as a result of the study of the onion maggot and other onion pests. In 1924 the lesser bulb fly was reared from infested onions collected in the field. The next year more extended studies of this new onion pest were made. A preliminary survey of the bulb-growing districts has revealed the fact that both the lesser bulb fly and the larger fly (*Merodon equestris* Fab.), and the bulb mite (*Rhizaglyphus hyacinthi* Boisd.) are widely distributed and thoroughly established in Oregon plantings.

The State and Federal bulb quarantine recently promulgated prohibits the movement of bulbs infested by the lesser and greater bulb flies. The hot water treatment now being investigated by the Station will kill the larvae in the infested bulbs, but bulbs in the field are still subject to infestation with no satisfactory field control available as yet. Studies of the life-history and preliminary field control tests based upon the egg laying habits of the insects have been made. It will be necessary to enlarge upon these studies this next season in order that the growers may have information for effective control available at the earliest possible date.

Symphilids (*Scutigerella immaculata* Newport). Tests for the control of this serious pest of garden and truck crops were undertaken at the urgent request of numerous truck and flower gardeners in the Willamette Valley. These gardeners report that they are unable to grow any vegetable crops because of the symphilids. This tiny centipede-like animal occurs in such numbers that it destroys all sprouting seeds and in one commercial planting has proved a serious pest of asparagus. Late in the biennium the pest was found in an aster plantation, causing serious losses estimated at more than $3,000. Grain soaked in bichloride of mercury solution appears to be of value in poisoning symphilids.

PARASITES OF THE EUROPEAN EARWIG

European earwigs were successfully infested in the insectary by one of the species of parasites *(Digonochaeta setipennis)* introduced from France and England, and puparia of this species were recovered from the parasitized earwigs. Success has not as yet attended the importation of the other tachinid-fly parasite *(Rhacodineura antiqua)*. During the winter and spring of 1924-25, 598 puparia of *Digonochaeta setipennis* were received at Corvallis and at the U. S. Bureau of Entomology laboratory, Forest Grove. Seventy-eight of these yielded two species of hyperparasites, *Dibrachys* sp. and *Plesignathus variabilis*. One hundred and eighty-six of the puparia, or 31 percent of the total, gave female flies.

These flies were mated and introduced into the earwig cages in Portland where they parasitized many earwigs. During the summer and fall of 1925, 125 puparia reared from parasitized earwigs were recovered. From these, 39 females emerged as a partial second generation, leaving on hand only 86 puparia.

During the fall and winter of 1925-26 shipments of puparia totaling 510 puparia were received from France and England.

Total Digonochaeta puparia on hand March 5, 1926.

Puparia reared in Portland insectaries	86
Puparia received 1925-26	510
Total	596

This is the available stock with which to begin the second year.

Some 25,000 live earwigs exposed to parasitism by *Rhacodineura antiqua* were received from France and England during the last two winters. Only four puparia were obtained from the importations of 1924-25 and only three flies emerged. It was not possible to mate these as they emerged at different dates.

From this year's importations 5 *Rhacodineura* puparia have been obtained up to March 1, 1926.

Total puparia on hand March 1, 1926, and available for the second season:

Digonochaeta setipennis	596
Rhacodineura antiqua	5

BEE INVESTIGATIONS

The native bees of Oregon. During the past five years as opportunity has made it possible a study of the native bees of Oregon has been carried on. When it is considered that the absence of bees is one of the limiting factors in fruit and seed production the value of this study will be realized.

Last spring a preliminary study of the relative number of native bees and honey bees visiting the blossoms of the more common fruit trees was made with the following results:

	Honey bees	Bumblebees	Smaller species of bees
	%	%	%
Cherries	80	5	15
Pears	90	3	17
Apples	99	½	½

It would appear from the above that the native bees are an important factor in obtaining a set of fruit when there is a shortage of honey bees. In the production of clover seed and some other seed crops the native bees are even more important.

The following lines of investigation are being carried on: (1) A study of the flower-visiting habits of the numerous native species, of which it is estimated there are nearly five hundred. (2) A study of the importance of each species in the pollination of agricultural plants. (3) A study of the life-history and distribution of each species.

The department collection now contains approximately 5,000 specimens of bees. These are largely from Western Oregon. Much additional collecting should be done in Eastern Oregon.

ADDITIONAL INFORMATION NEEDED

At the Agricultural Economic Conference held at Corvallis in January, 1924, the section on Beekeeping urged that the following lines of investigation be undertaken:

(1) A careful study of the cost of producing honey in the leading honey producing sections of the state.

(2) A study of the present methods of management to see wherein they should be modified to lower the cost of production. This applies especially to wintering methods, spring management, and disease control.

(3) A study of the honey flora of Oregon. The object of this study is to determine the factors influencing nectar secretion, the range of profitable bee pasturage, and the pasturing limit of occupied and unoccupied areas.

The need for such studies, especially of wintering, was further emphasized at the Umatilla County Economic Conference.

APPLICATION OF DUST INSECTICIDES BY MEANS OF THE AIRPLANE

Apparently one of the essential limiting factors in the application of dust insecticides by airplane is the lack of suitable hopper and dust release apparatus. In order to be successful it seemed necessary to devise a method whereby a given quantity of dust could be mechanically expelled from the hopper into the propeller stream in a given time. Such an apparatus was made and tested by means of the airplane on an apple

orchard at Monroe, Oregon, and in dusting alfalfa in Eastern Oregon for the control of the alfalfa weevil. In the trial flights 120 pounds of dust was put in the hopper. It was estimated that the airplane would have to cross the field of alfalfa eight times in order to apply the required two pounds of poison per acre. The ship actually crossed seven times and completed approximately three-quarters of the eighth crossing when the hopper was empty. No difficulty was experienced in later flights in controlling the amount of dust discharged. Full details of these tests may be found in Station Letter of Information No. 7.

DEPARTMENT OF AGRICULTURAL ENGINEERING

INVESTIGATIONS IN THE RELATION OF ELECTRICITY TO AGRICULTURE

Oregon Committee on Relation of Electricity to Agriculture organized. In May, 1924, at the instance of the National Committee on the Relation of Electricity to Agriculture, a state committee having objectives similar to the National Committee was formed. This committee is composed largely of farmers and representatives of electrical equipment and power companies. The purpose of the Oregon Committee is to obtain and disseminate facts concerning the use of electricity on the farm. The task of conducting investigations and making necessary studies was assigned to the Oregon Agricultural Experiment Station. The Director of the Station was chosen Chairman of the State Committee.

Agricultural survey made. A survey of 188 farms located along eight power lines in as many different sections of the state was made during the summer of 1924. Following are a few of the outstanding facts resulting from the study: (1) Electricity was used on farms chiefly for lighting. (2) Little use was made of electricity for revenue producing operations and little thought had been given to such use. (3) Cost rates for electric service were much lower to those farms using electricity extensively than to those using it for lighting only. (4) Twenty-six percent of the farmers along the lines studied were not using electricity because of inability to finance such use. (5) Few rural lines were profitable to the public service companies.

Investigations conducted since June, 1925. Four major projects and a number of minor ones were handled during this period.

Irrigation studies on fourteen farms in Western Oregon showed profits over cost of irrigation and in some cases a good crop in contrast with no crop without irrigation.

Thirty-seven tests have been run on prune driers of many types. Motor driven fans recirculating part of the heated air have increased the capacity of driers from 50 to 100 percent, improved the quality of the dried fruit, and lessened the drying cost. Tests of four hop driers indicated that the drying time can be reduced one-third by using fans to create forced draft. Tests of four walnut driers proved the need for forced draft to obtain rapid drying and maintain a high quality product.

Lighting laying houses during the months of October to April increased egg production of two pullet flocks and a flock of yearling hens. The project is being continued to determine the net gain for a full year. The influence of design upon heat distribution and ventilation in electric brooders was investigated in detail in the laboratory and the results checked by rearing chicks in the same brooders. Some machines were found to provide more uniform heat and better air movement than others. When properly operated, all of the machines tested were satisfactory for rearing good chicks.

Tests were made on four types of feed grinders to determine the reliability, adaptability, and cost of operation of each. The project is being continued.

Other minor projects included farm studies of electric incubation, electric chopping of green feed, an electric oat sprouter, motor driven apple graders, motor driven ensilage cutters, electric hay hoists and grain elevators, shearing sheep by electricity, and motor driven domestic water systems. Results of these studies are included in the 1926 Annual Report to the State Committee.

DEPARTMENT OF HOME ECONOMICS

THE PRESENT USE OF TIME BY HOUSEKEEPERS

Purnell Project Number 8. Station work in home economics was made possible by the Purnell Act. Beginning December 1, 1925, one person was employed to devote full time to development of work in this field in cooperation with the Resident Instruction and Extension Service staffs.

This project in the field of home management was undertaken upon unanimous recommendation of the state workers in home economics. Its aim is to supply a picture of Oregon homes so far as their management is concerned—this to serve as a background for further work in research and teaching.

This being the first study in home economics by the Station a good deal of time and effort was necessary to make contacts, meet with committees throughout the state, and obtain cooperation. By June 30, however, a total of 256 cooperators had been obtained in eleven counties of the state. A total of 126 records have been returned. A summary was made of the first fifty records to be presented as part of a report of the time study before the American Home Economics Association at Minneapolis, June 30, 1926.

RESULTS OF INVESTIGATIONS AT THE BRANCH EXPERIMENT STATIONS

THE branch experiment stations at Astoria, Burns, Hermiston, Hood River, Moro, Talent, and Union continued investigations along the lines of the previous biennium. The work of each station has been centered as in previous years primarily on the major agricultural problems of the respective agricultural section represented by

the branch station. In addition the branch stations have cooperated with the Home Station at Corvallis in a few investigations for solution of problems common to larger sections of the state or the state as a whole. The character of work and the results are stated briefly in the following pages.

JOHN JACOB ASTOR BRANCH STATION, ASTORIA

The Astoria Branch Station devotes its attention and study to matters pertaining to dairy production, forage crops for dairying, soil fertility, drainage, and land clearing.

The Legislature in session in 1925 increased the annual appropriation for this Station. This increase aids the Station to carry on its work, provide proper maintenance of buildings, and secure necessary improvements. There was such a great need for immediate repairs, long delayed, and some new equipment that full benefit of the appropriation for experimental purposes was not obtained until 1926.

DAIRY INVESTIGATIONS

Effects of supplementing pasture. A study of the production of this herd for several years shows that production of spring freshened cows decreases 45 percent from June 1 to September 15. The receipts of a large factory in this section prove the results obtained by the Station here are correct. By feeding green feed daily the drop in production was decreased from 25 percent to 30 percent for this period. The winter production following the feeding was maintained on an equally higher plane.

These results are being used by about one-half of the dairymen of Clatsop county in the management of their herds.

Dairy rations for winter feeding. One of the problems that this Station has been working on is the economical feeding of dairy cows for high winter production. During the last two winter feeding periods several rations were used. The ideal ration from the standpoint of economy, effect on production, and palatability was one consisting of 8 pounds hay, 40 pounds roots, 25 pounds silage, and 5 pounds grain for a 1,000-pound cow producing one pound of butter-fat per day. This ration used the maximum amount of forage that can be produced on a dairy farm and requires the minimum outlay for grain. The next best ration was one consisting of 12 pounds hay, 70 pounds roots, and 7 pounds grain.

Dairy herd improvement. Before extensive investigational work can be carried on it will be necessary to develop a uniform, good producing herd. The herd being developed at the Station is gradually being developed along these lines. Daily milk weights are being taken and tested monthly. Only economic producers are retained in the herd.

A new junior herd sire, Langwater Norman, was purchased this year in order further to improve the herd.

The herd has been a federally accredited herd for four years. The herd suffered two serious outbreaks of contagious abortion, one in 1916

and again in 1920. Blood tests have been taken at various times and tested by the Veterinary department at Oregon State Agricultural College. At the present time there are three cows which react to the test. These three cows are to be disposed of immediately. Every effort will be made to keep the herd clean of this disastrous disease.

CROP WORK

Roots. A variety trial of turnips, rutabagas, and mangels has been conducted for a period of three years. A comparison of these three types of roots shows that turnip exceeds the rutabaga in total yield per acre and in dry matter but has poor keeping qualities. The rutabaga is superior to the mangel in all these respects and in addition costs less to grow an acre. The mangel stores the best of any root but is not superior to the rutabaga if the latter is left in the field.

Effect of roots on flavor of butter. This work is being carried on cooperatively with the Dairy department of the College. No definite results have as yet been obtained.

Varieties of turnips. The Pomeranian White Globe, a superior variety, introduced by the Station, has been superseded by the Imperial Green Globe. The latter is equal in yield and has far better keeping qualities. It is also a later variety.

Work is still continued on the varieties of rutabagas and mangels. Our former recommendation as to varieties has not been changed.

Oats. The Grey Winter oats when spring planted has proved superior in yield and quality over all varieties of spring oats. It is also superior to spring oats in combinations with peas or vetch.

Japanese barnyard millet. Experiments as to the date of planting indicate that May 15 to June 1 is the best planting date for the north Coast section. This crop is increasing in favor each year as an ideal soiling crop for August and September.

Oats and vetch. A variety trial of the various vetches has been conducted for five years. Woolly Podded vetch has proved to be the best vetch. Common vetch ranks second. Vetch is well adapted to the Coast section and is an excellent forage crop adapted for hay, silage, or soiling. Results at this Station prove that inoculation is necessary for the successful production of this crop, that it must be inoculated artificially the first time it is grown and that soil inoculation is most successful. Pure culture is successful when lime is used.

Ladino clover is a pasture clover of great promise for the bottomlands and tide-lands. Trial at the Station covering a period of five years shows that Ladino clover is one month earlier than white clover and a heavier producer of forage.

MANURE AND FERTILIZERS

Soil fertilizers on upland. To date seven years' results are available on this project. The results of the last two years further strengthen the

conclusion that manure is essential to profitable and permanent production; that lime is beneficial to all of the desirable forage crops of this section and may be necessary to permanent agriculture; and that superphosphate is beneficial to most cultivated crops and especially to root crops.

COMMERCIAL FERTILIZERS ON RUTABAGAS ON UPLAND IN 1926

(Average increase in yield of rutabagas)

Fertilizer	Average No. of plots	Increase per acre (Tons)
		T.
20 tons manure	12	23.69
2 tons lime	6	9.76
300 pounds superphosphate	6	8.33
200 pounds potash	2	1.82
200 pounds nitrate of soda	2	1.09
200 pounds sulfur	2	.74

These results are outstanding and show the profitable fertilizers for the root crop. Mangels respond even better to lime than rutabagas. All rutabaga and turnip crops should receive an application of superphosphate. The results of these experiments are in general application through all of Clatsop county. In 1920 there was no superphosphate used in Clatsop county. In 1925, according to the estimates of the County Agent's Office, three car-loads were used. By forcing growth the application of superphosphate aids in the control of insect injury.

DRAINAGE

The experiment in drainage of tide-land by tile is proving satisfactory. This year 1,800 feet of additional tile were laid. The efficiency of tiling on tide-land increases with age, the least benefits being obtained the first two years after tile are laid.

MISCELLANEOUS SERVICE

Information. Each year the request for information increases. A large amount of newspaper publicity is obtained through the cooperation of the local papers. The results obtained at the Station are carried to the farmers generally through the various county agents' offices in the Coast section. Through their excellent cooperation these results have a very wide distribution.

Field days. A general field day is an annual event in June. The attendance is excellent of both farmers and business men. A special root field day was held in November.

Marketing. At the request of local dairymen the superintendent has taken an active part in aiding the development of cooperative marketing of dairy products. This organization has been a success and is today the largest cooperative creamery in Oregon.

HARNEY BRANCH EXPERIMENT STATION, BURNS

The main lines of investigation were continued at the Harney Branch Experiment Station for the years 1925 and 1926. Several new projects were started during the biennium.

The projects continued are as follows:

Varietal experiments on dry and irrigated land.
Fertilizer rotation experiments on irrigated land.
Duty-of-water experiments.
Wheat nurseries, irrigated.
Experiments with ensilage crops.
Experiments with shrubs, fruit, and shade trees.

New projects started:

Twenty-six new irrigated rotations.

Cost-of-production experiment
(a) Canadian field peas.
(b) Early Ohio potatoes.
(c) Grimm alfalfa.

Grimm alfalfa on dry land in rows for seed production.

Grimm alfalfa under irrigation for seed production.

VARIETAL EXPERIMENTS

The varietal experiments with cereals on dry and irrigated land were continued with the same varieties leading as in the past biennium.

Early Baart has proved to be superior to Hard Federation on the dry-land sections of Central Oregon. It has a longer straw, is slightly hardier, and shatters less than Hard Federation. Hard Federation has proved to be an excellent variety to grow under irrigation in sections that have a high water-table until late in the season. Under such conditions the crop must be sown late and, in order to mature, must be able to finish in a short growing season.

The Harney Branch Experiment Station has distributed Baart, Federation, and Hard Federation throughout Harney and some of the surrounding counties, until these varieties have replaced practically all others. This has resulted in materially increasing the yields.

FERTILIZER ROTATION EXPERIMENTS

These experiments are being conducted with the principal crops. To date the best results have been obtained with barnyard manure, and manure plus acid phosphate. The most efficient and economical fertilizer for Harney Valley is barnyard manure applied at approximately ten tons per acre.

DUTY-OF-WATER EXPERIMENTS

These experiments are being continued and the data obtained indicate that it is possible that former amounts recommended may be slightly low. The following amounts delivered at the farm should be ample to produce good crops under normal conditions:

Crops	Acre-inches
	in.
Sunflowers	30
Alfalfa	24
Field peas and clover	18
Sugar beets and mangels	15
Cereals	14
Potatoes	12

WHEAT NURSERIES

The winter wheat smut nursery and the Kansas white winter wheat nurseries are being continued. The results to date do not justify specific selections.

ENSILAGE CROPS

The experiments with ensilage crops are intensely interesting, and are to mean much to the successful handling of Harney county farms. The mammoth Russian sunflowers seeded in rows 21 inches apart at the rate of 30 pounds per acre have produced yields of 40 tons or better per acre for the past five years.

Canadian field peas grown alone or in combination with wheat, oats, or barley, are perhaps the most promising ensilage, or combination crop. This gives a balanced ration and the yields range from 12 to 21 tons per acre. The crop can be cured for seed, cut green for ensilage, cured for hay, or can be hogged or sheeped off, and is readily eaten by all classes of livestock. Under irrigation the field pea inoculates very heavily and the amount of atmospheric nitrogen added to the soil is remarkable. This season the Station produced nine acres of field peas and matured them for seed and they will be sold to several sheepmen who intend to grow them to sheep off next season.

TREES AND SHRUBS

This experiment has not been conducted long enough to make definite recommendations although several varieties of trees and shrubs are doing well.

IRRIGATED ROTATIONS

The old irrigated rotations were discontinued in 1924 and a new series of 26 irrigated rotations were started in 1925. As this is only the second year it is too early to draw conclusions. Past results show, however, that the Canadian field pea is undoubtedly the best legume for the short rotation. Alfalfa is the standard legume for the long rotation. In a few years we hope to obtain some valuable data from this new series.

COST-OF-PRODUCTION EXPERIMENT

This experiment was not started until the spring of 1926, hence no data are available. The two crops under investigation this season are Canadian field peas and Early Ohio potatoes. The results of this experiment will be of vital importance to all prospective farmers who intend to irrigate by pumping.

GROWING GRIMM ALFALFA ON DRY LAND IN ROWS FOR SEED

This experiment was started in 1921 and was enlarged in 1925. There is no question about the production of seed in this manner. It has been proved that it is practical and will probably be about the only crop that will pay on the poor quality of dry land in this section. One hundred pounds of recleaned Grimm alfalfa seed has been raised to the acre at this Station. In 1925 some 16 acres were seeded to Grimm in pairs of rows seven inches apart and the pairs spaced 42 inches apart. This crop has not been harvested, but all indications point to a good yield.

GROWING GRIMM ALFALFA FOR SEED UNDER IRRIGATION

This project was started in 1925, but as the seed crop for 1926 has not been harvested, there are no available data. There are several problems to solve in the successful production of alfalfa seed under irrigation and it was for that purpose that this experiment was instituted.

This Station has been instrumental in distributing Grimm alfalfa seed to the farmers at a reasonable price and as a result many farmers are now growing this variety which is the hardiest and highest yielding alfalfa grown today.

MISCELLANEOUS SERVICE

The Station representatives serve the farmers generally by supplying information requested, by personal calls, by telephone, and by mail. Field days are held and many farmers are shown over the Station in person and the experiments explained.

UMATILLA BRANCH STATION, HERMISTON

The Umatilla Branch Station is jointly maintained by the Oregon Agricultural Experiment Station and the U. S. Department of Agriculture for the purpose of investigating problems related to establishing and maintaining permanent agriculture on sandy soils under irrigation. The experiments conducted cover a wide range of projects, chief of which include experiments in soil fertility, irrigation practice, crop testing, and lamb feeding as a means of utilization of forage crops.

SOIL FERTILITY

For eleven years an experiment to determine the value of manure in increasing the yields of alfalfa and of corn has been conducted. In

this test manure was applied to each crop 6 years of the 11, at the rate of 8 and 32 tons per acre, making a total of 48 and 192 tons. Even though these heavy applications have been made the returns per ton of manure have been very good. The check plots did not receive manure. The yields given are of air-dry hay and green corn about ready for the silo.

The average yield of hay from the check plots which did not receive manure was 3.71 tons per acre; from the plots which received manure 6 times at the rate of 8 tons per acre, or a total of 48 tons, the hay yields averaged 5.07 tons; and from the plots which received manure 6 times at the rate of 32 tons per acre, or a total of 192 tons, the hay yields averaged 6.10 tons. The average annual increase due to the manure applied at the rate of 6 tons was 1.36 tons of hay, and to the application at the rate of 32 tons, 2.39 tons over the untreated check plots. The total increase from the light application for the 11 years was 14.93 tons, and from the heavy applications, 26.27 tons of hay.

Manure applied at the rate of 8 tons annually was much more valuable per ton than when applied at 32 tons per acre annually. The light dressing has given to date increased yields at the rate of .311 ton of hay per ton of manure, and the heavy at the rate of .137 ton per ton of manure. Since the manured plots are still producing more hay than the unmanured plots, the total increase of yield per ton of manure remains to be determined. Manure at the lighter rate is 127 percent more valuable per ton than the heavier.

The average yield of fodder on the check plots without manure was .71 ton per acre; with the light application of manure, 1.99 tons, and with the heavy application, 3.41 tons. The total increased yield from the light manured plots has been 14.01 tons, which was at the rate of .292 ton of corn per ton of manure. The heavy application has increased the yield 29.67 tons or .155 ton per ton of manure.

The manure applied at the light rate gave higher yields per ton than where applied at the heavy rate both on alfalfa and on corn. Since the increases in yields per ton of manure were practically equal for alfalfa and for corn, the manure was more valuable when applied to alfalfa than when applied to corn because alfalfa hay has a higher feeding value than corn silage.

Commercial fertilizers applied to alfalfa included nitrate of soda, potash in both the sulfate and chloride forms, acid phosphate, and sulfur. The average yield of the 4 untreated check plots was 5.23 tons per acre, while the average yield of the 9 treated plots was 5.02 tons. The highest yielding plot was an untreated one, the next highest received sulfur, and the third was another untreated check. Sulfur on the slightly heavier soils of this vicinity has given some increase in yields of alfalfa hay, but on lighter soils, such as that on which this experiment was conducted, it has not increased the yield. While this test conducted for four years is not entirely conclusive on the subject of commercial fertilizers applied to alfalfa on these light sandy soils, so far as this test is concerned, it proves that their use is not a profitable practice.

IRRIGATION EXPERIMENTS

The strip-border method of irrigation, which was first tried and recommended in the Northwest States by the Umatilla Branch Station, is quite generally used on the Umatilla Reclamation Project and has resulted in materially better use of irrigation water. A number of experiments have been conducted to determine what length and what width borders are most economical of irrigation water. Some of these tests have been conducted for 10 years and all of them for 5 years or longer. With the results of this number of tests available very accurate and definite conclusions can be reached. These tests were conducted on medium sandy soils of practically uniform texture. In these experiments different length and different width borders on both steep and flat land are used. Steep land is considered to be that having a fall in excess of 3 feet per 100 feet of run. In all instances the yields obtained in these tests from the flat land were much higher than those from the steep land. This was largely due to the fact that better stands and growth are obtained on the flat land because it is more thoroughly soaked and does not gully as does the steep land.

In general, it may be said that with heads of 3 or 4 second-feet of water on land not having excessive slopes, borders from 30 to 40 feet wide and from 150 to 200 feet long are the best sizes for sandy soils.

ALFALFA VARIETY TRIALS

Alfalfa variety trials are of the greatest importance because alfalfa is by far the most important crop for sandy soils under irrigation. On the Umatilla Project for a number of years almost 80 percent of the crop income has been derived from alfalfa. A test of 12 varieties of alfalfa has been conducted for 6 years, with an additional test of 9 varieties for 5 years.

During the winter of 1924-25 winter-killing of alfalfa was severe on the project and in neighboring sections of Oregon. The killing varied greatly from field to field, but is estimated to have been from 20 to 30 percent of the alfalfa stands. The killing did not take entire fields but covered rather large spots in places and in others was uniform throughout the fields. Observations showed that the killing was most severe where the plants were having a struggle for existence, such as being too dry or too wet, and particularly where the plants were growing on land which had been heavily graded in preparation for irrigation. The variety test at the Station was located on a rather good piece of land with conditions generally favorable; so the killing in that field was not as severe as in some of the other fields at the Station. It serves, however, to bring out the relative hardiness of the several varieties.

The most severe winter-killing occurred in the varieties of the tender group as represented by Chilean, Indian, and Hairy Peruvian. Two strains from dry-land grown seed had the highest winter-killing in the common group. The proportion of plants killed in the other varieties was not large enough to be of material consequence. One strain each of Grimm and Turkestan came through without killing, and the other two strains of these varieties had only slight killing. Winter-killing had not occurred previously during the history of the Station but similar

weather conditions might occur almost any winter, so it is believed that the hardy strains as represented by northern grown Common or Grimm should be grown to be safe.

The highest yields in the Common group were obtained from strains grown from dry-land seed D-38, from Black Hills seed, and from local seed. Seed D-38, however, killed rather badly. In the hardy group, Grimm gave the highest yield, with Liscomb second. The difference in yield of Black Hills Common and Grimm have not been pronounced enough to give decided preference to either, but Black Hills Common has the advantage that the seed is cheaper. In case local seed is used, care should be taken to see that it is free from weeds and that it comes from a field which has given good hay yields.

LAMB FEEDING EXPERIMENTS

During each of the past three winters a car-load of lambs has been fattened at the Station. The primary object of these tests has been to ascertain the practicability of marketing hay, under project conditions, by feeding it to lambs. The secondary object in one instance was to determine the relative value of corn, wheat, oats, and barley as grain supplements to alfalfa hay for fattening lambs, and in the other two instances to ascertain the best rate of feeding grain and means of carrying lambs preliminary to the fattening period, so as to put them on the late winter market. The lambs used in these tests were average quality cross-bred lambs. All the grain fed was whole, and all the alfalfa hay long. Approximately equal amounts of each cutting of hay went to each lot, so the kind of hay was not a factor in the results. The lots in each instance contained fifty head of lambs.

The first test included lambs fed corn, wheat, oats, and barley. This test was conducted for 99 days, during which time the lambs were fed all the hay they would clean up and 94 pounds of grain per head, which was a daily average of .95 pound. These lambs were rather small at the beginning of the trial, having an average weight of approximately 51 pounds. They made very good gains, however.

The corn-fed lot made a total gain of 36.2 pounds per head, which was a daily gain of .366 pound. The next highest, 34.5 pounds total or .348 pound daily, was made by the lambs in the wheat lot. The oats- and barley-fed lots made practically equal gains.

The hay offered per day to the corn-lot lambs was slightly the highest, with the wheat, barley, and oats lambs following in the order mentioned. The corn, oats, and barley lots wasted practically the same percentage of hay and slightly more than the wheat-fed lambs. Neither the hay nor grain required per 100 pounds of grain varied greatly with the different feeds. The corn and wheat lots hay requirement was higher than the oats and barley lots, but the grain requirements were the reverse. Taking barley as a standard, the corn was worth 8 percent more, wheat 3 percent less, and oats practically equal to barley. The finish was best and practically equal for the corn and wheat lots. The conclusion from this test is that the feeding values of the grain tested when fed with good quality alfalfa hay were practically equal. The choice of these feeds to be used would be governed by their prices.

In the other tests it was planned to carry the lambs on feed for 150 days and during that time to give them 75 pounds of grain per head at varying rates. Owing to weather conditions and the necessity of starting them on grain gradually, the exact number of days could not be governed, but the total amount of grain was not changed. In all instances, except during the preliminary period when lot 5 was on pasture, the lambs had all the alfalfa hay they would clean up. Lot 1 lambs had their grain at the rate of .52 pound per day for the entire 143 days. Lot 2 had no grain during the first 41 days, and their grain at the rate of .74 pound per day for 102 days. Lot 3 had no grain for the first 65 days and .96 pound of grain for the last 78 days. Lot 4 had hay alone for 87 days and 1.34 pounds of grain for 56 days. Lot 5 was run on alfalfa pasture for 57 days and received their grain practically as did lot 3 — .95 pound per day for 79 days. The initial weights were almost equal at the beginning of the test.

The lambs made only very small gains when carried on hay alone. It is interesting to note in this connection that almost as much gain was made by the lambs on hay 41 days as by those on hay as long as 87 days. In fact, the monthly weights showed that the lot on hay longest lost some weight during the latter part of the period. The lot on pasture gained 7.3 pounds. This food was cheaper than hay, so that considering the difference in gain it was much the more profitable method of carrying the lambs. The hay costs per 100 pounds of gain were extremely large while the lambs were on hay alone, being from 3,773 to 6,512 pounds. These costs were paid by the increase in the price of the lambs obtained by getting them on the late market.

When the hay and grain period is considered, Lot 3, fed .96 pound of grain a day during the grain period, made the largest gain per head; with Lot 1, fed .52, second; Lot 2, fed .74, third; Lot 5, fed .95, fourth; and Lot 4, fed 1.34, last. The gains per day increased directly with the amount of grain fed. The hay offered was practically equal for the lighter feeds and decreased little for the heavier feeds. The percent of hay refused increased directly as the rate of grain fed. The hay costs per 100 pounds of grain were inversely proportional to the amount of grain fed. The lowest grain cost was for Lot 3 and the highest was for Lot 4.

During the entire feeding period the lot which was run on pasture made the highest total gain, and the lot fed the heaviest grain rate made the lowest total gain. The two lots which received approximately one pound of grain made the best daily gain, although the lots all gained quite similarly. Little difference in the hay offered or the percent refused was noticed when the entire feed period is considered. The hay and grain costs were both highest for Lot 1, which was fed grain the longest. The lowest hay and grain costs were for Lot 4, which was fed hay for 65 days and hay and grain for 78 days.

The conclusions reached from this experiment are that the increase in the price of fat lambs during the winter months will pay for the hay required to carry the lambs prior to grain feeding, so that they can be put on the late market, and that this is an entirely practicable method of marketing hay.

During the three-year period covered by these tests lambs have paid $15.34 per ton for hay, which was 70 percent more than the average October 1 price after deducting all items of expense such as grain, labor, interest, insurance, and incidentals.

Station Bulletin 198, Fattening Lambs on Alfalfa, and Station Bulletin 218, Fattening Lambs for the Late Winter Market, have been issued as a result of this work.

HOOD RIVER BRANCH EXPERIMENT STATION, HOOD RIVER

APPLE-TREE ANTHRACNOSE

The investigation of the persistence of various types of bordeaux mixture and their influence on anthracnose has been continued. A bulletin is now being prepared covering the results of this investigation. The copper in the bordeaux was found to persist for long periods. Regardless of the time of spraying, all applications have a bearing on reducing the disease. With the disease well in hand, the spring bordeaux-oil application will prevent any serious advance. Bordeaux 6-6-50 applied as a delayed dormant spray persists sufficiently well to effect fair control even though the disease does not become active until fall. Summer bordeaux applied with arsenate of lead is effective in bringing about control of the disease.

SCAB SPRAY INVESTIGATION

Owing to almost complete absence of the disease in the Hood River district, investigations relative to scab control have been postponed until more favorable conditions prevail.

PERENNIAL CANKER

During the past two years in the anthracnose control study it was observed that a particular form of canker similar in many respects to anthracnose was not being controlled by any of the treatments employed. In many instances annual extensions were found taking place which were not characteristic of anthracnose advance. During the spring of 1925, the causal organism was isolated and described by the Station in Bulletin 217, Perennial Canker of Apple Trees. This disease is not controlled by the various forms of bordeaux employed in handling anthracnose. How, and at what time infection takes place is not known. There appears to be some relationship between the presence of woolly apple aphids and the advance of the disease. Winter injury as caused by severe winter freezing seems to be associated with the spread of the trouble. The various behaviors of the fungus and possible means of control are being studied. Infection occurs only at points of injury such as broken spurs, pruning wounds, and the like. Growers are being advised to delay pruning as late as possible in the spring as it is believed rapid callous growth will have a tendency to reduce possibilities of infection. Painting of large wounds with a wound dressing is advised.

CODLING-MOTH

The study of the seasonal behaviors of the codling-moth for the purpose of determining useful dates for spraying purposes has been continued. A four-year study of the comparative values of double strength and single strength arsenate of lead, 2 and 4 pounds to 100 gallons, with and without calcium caseinate as a spreader, has been completed. The double strength lead gave consistently better control of the codling-moth. Averaging the four years' results, the difference obtained through the addition of a spreader is within the range of experimental error. This same similarity in results so far as the spreader is concerned occurred with the single strength applications. It can be definitely stated that the addition of calcium caseinate under conditions as applied in Hood River does not increase the control of the codling-moth. The use of a spreader does improve the finish of the fruit to a certain degree in that no mottling of the skin occurs as a result of irregular coating of arsenate of lead.

BLISTER MITE OF APPLES

The Blister Mite affecting apples has developed into a serious pest in many sections of the Northwest. As a result of two years' investigation at Hood River the comparative values of various spraying materials have been determined. Results of various tests carried out in 1924 have been published in Station Circular 59, Apple Blister-Mite and Its Control. Fall applications using lime-sulfur at a strength of 1-15 or stronger have been found effective. Lime-sulfur applied in the spring was found superior to oil sprays. Bordeaux oil does not give good control when applied in the spring.

PEAR SPRAYING INVESTIGATIONS

Observations are being continued as reported for the last biennium. Pear diseases controllable by sprays have continued to be of little consequence. Conclusions cannot be definitely presented at this time.

STRAWBERRY ROOT-WEEVIL CONTROL

As reported for the previous biennium an oil barrier, devised by British Columbia investigators, has been tested. The barrier did not prove successful under conditions as existing in Hood River. Excessive winds which occurred during the spring not only blew the oil from the barrier but, through the accumulation of dust, often made it possible for the beetles to enter the field. Tanglefoot used at joints became dust-covered within a few hours enabling beetles to cross at these points. Regardless of the fact that every precaution was taken throughout 1924, the infestation was found to be quite serious and general in 1925. Preliminary tests have been made, using "Go-West" weevil bait to determine its practicability in this section.

ORCHARD FERTILITY INVESTIGATIONS

During 1924 cooperative tests between the Hood River Experiment Station and the department of Agricultural Chemistry were continued in determining the amount of nitrate nitrogen and ammonia in typical Hood River soils. Results were consistent with earlier findings in 1924 in that nitrate nitrogen was present in larger quantities during midsummer than during early spring. Nitrate nitrogen was present considerably earlier than was true in 1924 and may be attributed to an earlier growing season. It is also noteworthy that this form of nitrogen persisted in fairly large quantity during a greater portion of the winter of 1925-26. On February 13, 1926, the nitrate content was still high in most of the soils, although apparently declining somewhat from the content noted in previous analyses. The ammonia in some of the samples had disappeared altogether. On the Parkdale Loam comparisons in nitrate content were made between orchards continuously subjected to clean cultivation with no cover crops and those in which Hairy vetch and alfalfa were employed. On an average, where alfalfa of long standing has been employed with but one annual spring cultivation, the nitrate content was lower than where volunteer Hairy vetch has been employed with clean cultivation or where alfalfa has been plowed up and followed by intensive clean cultivation throughout most of the growing season.

Continued studies have been made bearing upon the ultimate value of commercial fertilizers in bearing apple and pear orchards. Results are, in the main, consistent with previous observations in that economical responses have not been obtained from applications of phosphorus or potassium alone or in combination. Quick-acting nitrogen fertilizers such as nitrate of soda and sulfate of ammonia are outstanding in point of practical results. On the other hand, the use of nitrate of soda, sulfate of ammonia, "mixed fertilizers" and sheep manure in a typical Newtown orchard on a Hood Silt soil has not materially increased yield or improved the grade of fruit after three annual applications.

Observations continue to favor the use of quick-growing leguminous cover crops such as Hairy vetch, the biennial sweet clover and the Hubam (annual) sweet clover. Alfalfa does not appear to be as well adapted for shade crop purposes on the Parkdale Loam type as is true on the Lower Valley soils such as the Hood Silt and the Underwood Loam, both of which are of a heavier character and favored with a longer growing season. The use of alfalfa in the young orchard has been found detrimental in that this crop exerts a retarding influence on tree growth. The results probably are largely influenced by the amount of nitrate nitrogen obtaining under typical growing conditions.

FERTILIZATION OF SMALL FRUITS

Further tests bearing upon the problem of strawberry fertilization were made. These included both mineral and organic fertilizers. Fall applications were compared with spring applications and combinations of the two methods. The percentage of nitrogen used was relatively high. Results from these tests do not warrant definite conclusions, hence observations must be continued.

Results of topping experiments indicate a better grade of berries and higher yields from plants so handled preferably within two or three weeks following harvest.

The influence of barnyard manure applied in the fall or spring and reinforced with mineral fertilizers on Cuthbert red raspberries has been studied. Yields obtained in 1925 are consistent with those obtained in 1924 in that fall applications of manure have proved more practical. These observations are being checked against another test where fall and spring applications of several fertilizers are being made.

PRUNING EXPERIMENTS

Since the spring of 1922, studies have been made bearing upon the influence of various amounts of nitrate of soda as a fertilizer on bearing Newtown trees, when influenced by different types of pruning such as thinning out, heading back, and combinations of these practices. The trees have never borne heavily and are growing in alfalfa sod. Heavy pruning and fertilization have not greatly influenced the performance of these trees. The tests show clearly the difficulty of obtaining adequate growth in the lower portions of the tree and this is reflected in failure to obtain a desirable number of new fruit spurs, where heavy annual spring pruning is practiced.

Observations are being continued bearing upon the influence of summer, winter, and no pruning of Anjou trees nine years old in 1925; also on trees artificially spread by the tying down of limbs as previously reported. These tests were started in the spring of 1920. Trees receiving no pruning have made greater aggregate growth annually than trees either winter or summer pruned. Such trees are not only larger but possess a greater number of fruit spurs. Non-pruned trees have also borne more heavily, as is also true of trees with artificially spreading limbs. The relative merits of the different systems of handling have been obscured by frost injury to the blossoms in 1924 and excessively cold rains during a similar period of 1925. Observations on the influence of different pollenizers both years have also been rendered unreliable for similar reasons.

POTATO FERTILIZERS

Continued studies with potato fertilizers indicate economical responses from fairly heavy applications of nitrate of soda or sulfate of ammonia with superphosphate. A test of interest was conducted in 1925 in which sulfate of ammonia comprised 28.5 percent by weight of the fertilizer mixture and the balance was made up of superphosphate. Applications varied from 350 to 2,800 pounds per acre and obtained, both in the case of whole seed averaging approximately three ounces and cut seed, one and one-half ounces. The cost of seed and fertilizer varied from $38.40 to $130.76 per acre. Briefly, the largest gross tonnage, 407.4 sacks per acre (ungraded) was obtained where maximum expense was incurred for seed and fertilizer. On the other hand when deductions were made, it was found that with either whole seed or cut seed, maximum net returns were realized from applications of fertilizer costing approximately $30.00 per acre. These results were obtained on a soil where an old stand of alfalfa was fall plowed.

HARDY STOCKS

Severe winter injury to bearing apple and pear trees in the Hood River Valley, particularly in 1919 and 1924, indicates clearly the need for hardier stocks capable of withstanding low and rapidly fluctuating temperatures such as obtained during those test years. Spitzenburgs especially are tender and the Newtown only semi-hardy. Young pear orchards, even on favorable locations, have sustained heavy losses. This is particularly true of trees growing on Japanese roots. Hood River Branch Station is recommending the use of French roots only, for pear propagation in this district. As a general rule greatest damage has been in the trunk and main scaffold limbs. The possibility of using hardy pear and apple stocks for trunk and branches on which our more tender varieties may be top-worked is receiving study at this Station. An orchard survey partly completed in 1925 indicated that Comice and Easter pear trees possess unusual hardiness and may be used for this purpose. Mammoth Black Twig is also a hardy apple stock. Other stocks under study are Old Home, Estella, Ussuriensis, Serotina, Surprise, and Crab stock of a hardy character.

THE SHERMAN BRANCH EXPERIMENT STATION, MORO

The experimental work at this Branch Station, which is carried on cooperatively with the Office of Cereal Crops and Diseases of the United States Department of Agriculture, includes:

1. Varietal and rate-and-date of sowing experiments with wheat, barley, oats, peas, corn, and potatoes.

2. Cereal breeding investigations mainly with wheat for the purpose of producing high-yielding, disease-resistant, better-quality cereals.

3. Tillage experiments to determine the most economical methods of handling summer-fallow for winter wheat production.

4. Soil moisture and nitrate investigations to find out what effect various tillage methods have on the accumulation of nitrate nitrogen in the soil, and the absorption and retention of moisture in fallow land.

5. Crop rotation experiments, mainly to determine what crops, if any, can be profitably grown in systematic rotations with grain on the dry lands of Eastern Oregon.

BETTER CEREAL VARIETIES

Farmers of Eastern Oregon have been anxiously awaiting the distribution of a productive, smut-resistant winter wheat. The Branch Station at Moro will distribute, in the fall of 1926, 250 bushels of a new smut-resistant winter wheat, which has been named Regal. This variety is a purple-strawed selection from Turkey 1,571. It is sufficiently resistant to smut that seed treatment will be unnecessary. In field plot trials at Moro, Regal has slightly outyielded the standard Turkey wheats.

Two other promising smut-resistant winter wheats are Turkey 889-5 and White Odessa. Results from some of the outlying nurseries indicate that, in some localities, Turkey 889-5 may be a higher yielding wheat than Regal. Of the white-kerneled varieties in the smut-resistant group, White Odessa has been the highest yielder. Though a high yielding wheat in some locations, its usefulness is limited because of its late maturity and rather weak straw.

The average yields of Kharkov, the standard wheat of the Turkey type in Eastern Oregon, Regal, and White Odessa in replicated field plots at Moro for the four years (1923 to 1926) inclusive, were as follows:

Regal	28.6 bushels per acre
White Odessa	27.8 bushels per acre
Kharkov	27.5 bushels per acre

The average yields of these three varieties and Turkey 889-5 in three dry-land nurseries in Eastern Oregon (Moro, Pendleton, and Dufur) for the three years 1924 to 1926, inclusive, were:

Turkey 889-5	30.9 bushels per acre
White Odessa	29.2 bushels per acre
Kharkov	28.9 bushels per acre
Regal	28.5 bushels per acre

SPRING GRAIN VARIETIES

The value to wheat producers of Federation and Hard Federation spring wheats was strikingly emphasized in 1925, when about 400,000 acres of these two varieties were grown because of the extensive winter-killing of fall-sown wheat. The average yield of these two varieties, conservatively estimated, was at least three bushels per acre more than other spring wheats. Federation and Hard Federation, first distributed from the Moro Station in 1921, are now the only important commercially grown spring wheat varieties in Eastern Oregon.

Two selections made at Moro from Hard Federation, 31 and 71, are apparently superior to Hard Federation in yield and in some plant characters. A limited quantity of these will be distributed to farmers for trial in the spring of 1927.

In long time trials, Mariout and Meloy spring barleys have proved best for general culture on Eastern Oregon dry lands. Three new two-rowed barleys, C. I. 1429, and 2359, recent introductions by the United States Department of Agriculture, give promise of being even better than Mariout and Meloy.

Marton oats, a smut-immune variety developed at Moro, is now an established commercial variety in the Northwest. Hybrids with Markton and other commercial varieties have resulted in the isolation of a number of promising smut-immune types with plump, white kernels. These are being increased as rapidly as possible and tested for yield.

OUTLYING NURSERIES

For the past four years cereal nurseries have been grown in several Eastern Oregon counties for the purpose of testing the adaptability of

new varieties of cereals under varying soil and climatic conditions. Nurseries have been maintained in Umatilla, Morrow, Wasco, and Crook counties in cooperation with the county agents. A nursery has also been grown for the past two years near Condon in Gilliam county and near Kent in southern Sherman county. The land in all cases is furnished by interested farmers. The grains are grown in triplicated three-row blocks, harvested by hand and threshed with the nursery thresher at Moro. These nurseries, with practically the same varieties grown in each, have furnished valuable information not only on comparative yields under varying conditions but on plant characters and winter hardiness as well. Annual field days are held at each nursery.

CEREAL BREEDING INVESTIGATIONS

In the cereal breeding investigations, which have been enlarged during the past two years, continued emphasis has been placed on the hybridization and pure line work with wheat. The Moro Station is trying to develop more desirable and productive smut-resistant winter wheats, and a type of wheat similar to Federation but more winter hardy. Federation, when fall sown, has proved unusually productive when not injured by cold weather. Several very promising winter wheats have been developed from crosses with Federation and Fortyfold. These are early-maturing, stiff-strawed wheats that are more winter hardy than Federation. A number of promising smut-resistant selections from hybrids between White Odessa and Hybrid 128 and between White Odessa and Federation are also under trial.

Hybrids between Markton oats and Sixty Day, Early Champion, Scottish Chief, Swedish Select, and Three Grain have been made and smut-immune strains isolated that are being tested for yield in nursery rows with the hope of obtaining a productive white oat of better quality than Markton.

TILLAGE, CROP ROTATION, SOIL MOISTURE, AND NITRATE INVESTIGATIONS

The results from the tillage and crop rotation experiments, which have been in progress since 1912, have not changed in any essential particular since the publication of Station Bulletins 190, Wheat Growing After Fallow, and 209, Dry-Farm Crop Rotation Experiments at Moro, Oregon, and Bulletin No. 1173 of the United States Department of Agriculture. A paper by Professor J. S. Jones and Geo. A. Mitchell, giving the results obtained in the soil moisture and nitrate investigations, has been accepted for publication by the Journal of Agricultural Research of the United States Department of Agriculture.

SOUTHERN OREGON BRANCH EXPERIMENT STATION, TALENT

Since most of the work of this Station is devoted to fruit trees and the leading projects require several years for completion, the work dur-

ing the past two years has been largely a continuation of the projects discussed in the last Report. Some important new work, however, has been started during the past two years.

BLIGHT RESISTANCE IN PEARS

The work on this project was begun in 1915 and has been carried on continuously for the past twelve seasons. During the first ten years of this period thirty-two species of pears, including practically all the known species, were tested for blight resistance. The results of this work were published in 1925 in Station Bulletin 214, Blight Resistance in Pears and Characteristics of Pear Species and Stocks. In the tests it was found that the vast majority of these species are highly susceptible to blight and the work with most of them has been discontinued.

Our work with the five most important species is being continued and has been enlarged with the three most promising of these. Two of these species, *P. calleryana* and *P. ussuriensis,* have shown a very high degree of resistance to blight, and the third, *P. communis,* which includes the French seedlings, has always been the most important pear stock used in this country. *P. communis* is in some respects superior to all others as a stock for our American varieties of pears. We have found that there is great variation among the types within each species and our major work is now devoted to finding the most valuable types and seedlings within each of these three species.

In the case of *P. ussuriensis* we have found that the variety Ba Li Hsiang produces the most vigorous and resistant seedlings and our work is now being concentrated on this type.

In *P. calleryana* our type No. 2 has produced the most desirable seedlings.

Since the French seedlings, *P. communis,* possess so many desirable stock characteristics, a special effort is being made to find strains of these which are resistant to blight, and which will transmit this resistance to a high percentage of their seedlings. The preliminary work with some of these types looks extremely promising. One variety of this species, Old Home, is highly resistant to blight and, fortunately, also has the power to transmit this characteristic to a very high percentage of its seedlings. In 1925 only 2 percent of these seedlings developed root blight while more than 40 percent of the ordinary imported French seedlings developed the disease when inoculated under similar conditions. During the past two seasons approximately twelve thousand French seedlings have been inoculated with blight. The vast majority of these were readily killed by the disease. A considerable number, however, have proved immune. These immune trees will be used as mother seed trees for the production of resistant root stocks for our cultivated varieties.

The work with pear root cuttings at this Station during the past three years has shown that only a small percentage of the cuttings grow under our conditions. The indications are that this method of propagation will not prove feasible in this Valley. Very few of the cuttings of *P. ussuriensis* make any growth whatever, while most of the *P. calleryana* and French cuttings make a slight top growth but fail to develop new roots, and hence soon wither and die. This applies especially to root

cuttings made from trees several years old which have been tested for blight resistance.

The work with hardy and blight resistant trunk stocks for pears has been continued during the past two years. Some of the varieties which appeared promising during the earlier stages of this work have developed certain undesirable traits and have been discarded. The variety known as Old Home has proved the most desirable of all those tested up to the present time.

PEAR BREEDING

The pear breeding work has been continued during the past two years. The object of this work is to produce new and desirable blight resistant varieties. Crosses have been made between the best blight immune Chinese varieties and the finest varieties of American pears. The earlier hybrids produced have proved vigorous, and a high percentage of them are resistant to blight. Fruit buds are now forming on part of the seedlings and the first crop will be produced in 1927. It is hoped that some of these new types will produce fruit of desirable size and quality.

Extensive work is being done to determine the best female and male parents for producing the most desirable seedlings for stock purposes. As indicated in a preceding paragraph, very desirable mother seed trees have been found in each of the three most desirable species. Work is now in progress to determine which male trees will give the best combinations with these mother trees. The preliminary results look extremely promising. For example, it has been found that when the blossoms of Ba Li Hsiang are crossed with the pollen of Lo Suan Li the seedlings resulting from such seeds are superior to those fertilized with any other male parent tested.

VALUE OF BORDEAUX MIXTURE IN COMBATING PEAR BLIGHT

Experiments at this Station during the past three seasons have shown that bordeaux mixture applied immediately preceding and following the blossoming period materially reduces the number of blight infections on pears in Southern Oregon. The results of this work have been published in the Seventeenth Annual Report of the Oregon State Horticultural Society. The results for 1926 are similar to those recorded in this report.

PEAR PICKING AND STORAGE WORK

During the seasons of 1925 and 1926 this Station has cooperated with the Home Station at Corvallis in an extensive experiment to determine the best time of picking, and methods of cold storaging the Bosc and other late varieties of pears. Some very valuable results have already been obtained with the Bosc which should materially reduce the losses heretofore sustained with this variety in the commercial cold storage houses. A preliminary report of this work was published in the Seventeenth Annual Report of the Oregon State Horticultural Socie-

ty. In 1926 the work was enlarged to include Anjou, Comice, and Winter Nelis. This work with all of the varieties mentioned will be continued for at least another season.

CODLING-MOTH CONTROL

During the past two seasons experiments have been conducted to ascertain the best method of controlling codling-moth under our conditions. In these experiments the value of single and double strength arsenate of lead, arsenate of lead alone and combined with summer oil, oil alone, and paste and dry arsenate of lead, are being compared. During 1925 arsenate of lead plus one percent oil and spreader gave somewhat better control than arsenate of lead and oil without the spreader. When the arsenate of lead and oil plus spreader was used less than 1 percent of the fruit showed oil burning, while where the arsenate of lead and oil without spreader was used 3½ percent of the fruit showed spray burn.

The experiments have not yet been concluded for 1926, but Newtown apples on all the oil sprayed plots show oil spray injury. On the fruit this injury is largely confined to the basin around the calyx. In 1926 the oil sprays also caused considerable injury to the foliage. It is very evident that in the case of Newtown apples, during dry seasons, the injury caused to the fruit by oil sprays will outweigh the benefits derived from the oil in better moth control.

SAN JOSE SCALE CONTROL

Experiments have been conducted during the past three years to determine the comparative value of lime-sulfur and various oil sprays for controlling San Jose scale. In 1924 entirely satisfactory results were obtained with both lime-sulfur and oil emulsions. During 1925 the oil emulsions gave from ten to twelve percent better control of scale than did the lime-sulfur. Lime-sulfur appears to be more effective during some seasons than others, apparently due to differences in weather conditions following the application of the spray.

In 1926 a dormant application of Brown Neutral oil emulsion caused considerable injury to part of the fruit buds of Winter Nelis pears.

NEW BOSC AND WINTER NELIS STRAINS

Bosc and Winter Nelis are two of our most important varieties of pears grown in Southern Oregon. Under favorable conditions these varieties develop an attractive russet color and the market pays a premium for such fruit. On some of our soils these varieties develop comparatively little russet and possess an unattractive green color. For years this Station has been seeking a strain of each of these varieties that would develop a desirable russet color every season on all of our soils. Three years ago a thoroughly russeted strain of each of these varieties was observed. These new strains have been fruited at this Station and fortunately reproduce true to type. These evidently will prove far more profitable than the old standard strains.

NEW SPITZENBURG APPLES

On our heavy clay and adobe soils the Spitzenburg apple does not develop a typical and desirable red color. Five years ago the superintendent of the Branch Station found a very dark red sport of this variety on a tree in the Umpqua Valley. Scions of this were procured and propagated at the Station. Fortunately this strain has proved a true mutation and reproduces true to type. On our heavy soils it develops a very attractive red color, and hence is far superior to the normal strain.

FIELD CROPS

Alfalfa varieties. The three leading varieties of alfalfa have been tested thoroughly at this Station. In this test the Common alfalfa has proved fully equal although not superior to the Grimm. Both of these varieties have given splendid results. The Turkestan alfalfa has proved inferior to the other two varieties.

Vetch and field peas. For several years this Station has conducted comparative tests with the various species of vetches, the tangier pea, and some of the field peas to ascertain which are the best orchard crops for this Valley. In these tests the Hungarian and Woolly Podded vetches have proved superior to the other species. The Spring or Oregon vetch and the Bitter vetch are not adapted to our very heavy soils, and the former often winter kills. We have never been able to get a satisfactory stand of the Tangier pea. The Austrian Winter pea has proved very hardy and vigorous, and makes a desirable winter cover crop. The other varieties of field peas are not dependable, since they often winter kill.

Federation wheat. This variety, introduced by the Sherman Branch Experiment Station, has been tested and introduced into Southern Oregon by this Station. Here it has proved a very productive and valuable variety.

Tomato varieties. The canners of Southern Oregon are vitally interested in better varieties and strains of tomatoes; hence this Station is making a study of the most promising types available. In our tests some of the strains of Bonny Best are proving superior to all other varieties. Owing to our comparatively short season the late varieties are not satisfactory.

EASTERN OREGON EXPERIMENT STATION, UNION

LIVESTOCK

Growing and fattening beef steers. Steer calves and yearlings carried through the winter months on maintenance or even submaintenance rations make considerably more gains on grass during the grazing season than do those that have been wintered on fattening rations, hence the conclusion that where these calves and yearlings are to be turned on grass it is more economical to have them come from the winter feed

yards comparatively thin rather than in a fat condition. Records are kept covering gains made during the growing and fattening periods, feed and labor costs, as well as dressing percentage, yield, confirmation, and grade of dressed beef.

Growing beef heifers. Due to the experience gained from the results obtained with growing steers it was decided to determine whether or not such methods of handling would be applicable to heifers which were to be used for breeding purposes. One hundred head of heifer calves were divided into ten lots, two of which were placed on each of the following rations: (1) straw and 4 pounds of alfalfa, (2) alfalfa (half feed), (3) alfalfa hay and silage (medium feed), (4) alfalfa hay (full feed), (5) alfalfa hay and 3 pounds rolled barley.

The heifers in the odd lots were bred to calves as two-year-olds, while those in the other lots are not to calve until three years old. After grazing upon the National Forest during the summer months and carried through two winters on the above rations there is a difference in weight, as two-year-olds, of 273 pounds in favor of the heifers which were fed alfalfa hay and 3 pounds rolled barley over those that received straw and 5 pounds of alfalfa hay. Likewise the average birth weight of calves from heifers in the grain-fed lot is 68 pounds while 62 pounds is the weight for the light-fed lot.

Winter rations for ewes. Alfalfa hay has proved to be a most satisfactory winter feed, but it is oftentimes supplemented with other feeds such as grain or silage to good advantage. While these are usually fed as after-lambing rations, especially is this true of silage; however, this supplement has been fed to ewes before lambing without any injurious effects.

Due to severe winter conditions some alfalfa plantings were killed; hence stockmen were forced to feed other hay. To meet this condition the Station planned a test to determine the relative value of legume hay in comparison with that of mixed hay fed with and without grain supplement, the results of which were decidedly in favor of the alfalfa.

Good results were obtained, however, by feeding mixed hay and one-half pound of barley.

Fattening lambs. There has been a marked increase in farm flocks and likewise considerable interest in feeding lambs throughout this section of the state. The Station has therefore strengthened its investigations along these lines during the biennium.

Experiments were conducted to determine the relative value of our small grains such as barley, wheat, oats, rye, corn, and peas, for lamb feeding work. Alfalfa hay was used as the standard roughage. This was fed long, chopped, and in the meal form, and was likewise supplemented in some cases with silage and molasses.

Among the small grains corn apparently was the most fattening; and likewise among the supplementary rations, alfalfa meal, molasses, and barley produced the most rapid gains; however the most satisfactory ration for Eastern Oregon conditions is alfalfa hay and barley.

Farm flock. The Station maintains a farm flock unit of 100 head of well-bred Hampshire ewes, demonstrating practical methods of management, records being kept covering wool and lamb production as well as an itemized statement of all feeds and labor throughout the year.

Swine. A breeding unit, consisting of ten Poland Chinas and ten Berkshire sows including pure-bred sires, is maintained for the purpose of determining desirable methods of feeding and care for both matured animals and for growing and fattening pigs.

A test to determine the advisability of flushing and non-flushing of both thin and fleshy brood sows at the time of mating was made last year and will be continued again this summer.

Wintering brood sows. The ration that has proved the most satisfactory and economical for Eastern Oregon farm conditions is a mixture of chopped alfalfa and rolled barley fed either wet or dry at the rate of two parts of alfalfa to one of barley by weight. At the time of farrowing, this ration is usually supplemented with mill-run and Digester Tankage and fed wet, using equal parts of alfalfa and grain.

Growing and fattening pigs. Experimental tests are under way which have for their purpose the determination of satisfactory methods of handling to meet specific farm conditions, such as confront the dairyman, wheat grower, and diversified farmer. From present results it would seem that the early turnover in which the pig is carried to a marketable weight as early as possible is the most profitable.

An experiment is now under way comprising four lots of pigs on Ladino clover pasture with rolled barley from self-feeders. In addition to this, one lot has skim milk from the dairy, another Digester Tankage, and the third mineral feed, while the fourth serves as a check without any supplementary feeds.

Dairy herd unit. Possibly the most marked achievement in connection with the dairy unit at this Station is the work accomplished in developing a herd by the use of an outstanding sire. Starting with grade cows and mating with one of the best sires that could be obtained the Station now has a young herd with remarkable uniformity in both conformation and butter-fat production.

Experimental tests are being conducted with the view of ascertaining desirable feeds and pasture mixtures as well as feasible methods of herd management to meet Eastern Oregon conditions.

Field crops. Investigations comprising tests with cereals, forage, hay, and pasture crops have been continued from year to year.

Grimm alfalfa leads as a hay crop, likewise corn in most sections is the most desirable silage plant, with a mixture of peas and barley a close second. Sweet Clover has proved itself a valuable pasture plant; especially is this true on types of soils not adapted to the growth of other pasture crops. Ladino clover likewise gives promise for pasturage purposes on the better types of soils.

Varietal trials. Rather extensive plantings are made each year covering varieties of wheat, both fall and spring, oats, barley, peas, and flax. In addition to the varietal trials in connection with cereals, some breeding and pure-line selection work is also under way.

Nursery trials. A very popular feature of the cereal investigations are the nursery plantings, both at this Station and at the Sand Ridge cooperative test. It is the intention to extend this field of work into sections of Wallowa and Baker counties as rapidly as conditions will permit. Much of this work could not have been attained, if it were not for the hearty cooperation and support given by the Moro Experiment Station.

Rotations. A comprehensive system of rotation tests is under way, having for its object the determination of a cropping plan adapted to Eastern Oregon conditions, that in the main will tend toward a more permanent and profitable system of agriculture.

Fertilizers. Anticipating a future need for such information this Station began a test several years ago in which various commercial fertilizers including farm manure are applied to such crops as wheat, peas, and barley, corn, and alfalfa, noting the effect upon yields resulting from such applications as compared with those of untreated check plots.

Head lettuce. As a result of tests conducted at this Station head lettuce has been grown commercially for the first time in Union county. Several car-loads of excellent lettuce were shipped from this county last year and more will be produced this coming season.

Tree nursery. Cooperating with the State Highway Commission the Union Station has propagated and grown several thousand ornamental trees to be planted along the State highways. One of the most promising for this district is the Russian Olive, a tree of comparatively rapid growth, very hardy and attractive.

Irrigation. An urgent request was made by the Union County Chamber of Commerce for authentic information as to what might be expected in the way of increased crop yields resulting from a sensible application of water to the sandy soils of the Grande Ronde Valley and likewise what might be the advantage and feasibility of the use of electricity in connection with such farm operations. The Experiment Station in cooperation with the Soils department and Extension Service of Oregon State Agricultural College, the Eastern Oregon Light and Power Company, the General Electric Company, and Mr. Hugh Huron established a demonstration unit at Imbler, Oregon, where water is pumped from a neighboring stream by means of electricity for irrigation purposes. Due to some unavoidable delays in installing the plant the water was not applied to the growing crops as soon as it should have been; however there is a decided difference in appearance between the crops on the various plots that have received water and those which have not.

Records are being kept of the amount of water required to obtain the most satisfactory yields, time and method of application, amount of electric power required, its cost and practicability for such purposes.

SERVICE

A "Feeder's Day" is usually held in the early spring at a time when the livestock are still in feed yards. The stockmen avail themselves of the opportunity to gain first-hand information by actually seeing results obtained by the various methods of feeding and handling.

A "Grange Picnic" is held each year at the Union Branch Experiment Station during the latter part of June. Many Grangers and their friends throughout Baker, Union, and Wallowa counties visit the Station and go over the experimental work of the institution at that time.

In the interest of better agriculture the "Field Day" sponsored by the County Agricultural Agent is another event during the year where farmers visit various points of interest throughout the Valley including the Branch Station.